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MARINE ENGINEERING.

Vol. 2. NEW YORK, NOVEMBER, 1898. No. 11.

S.S. WINIFRED, THE PIONEER AMERICAN STEEL CARGO OCEAN STEAMSHIP.*

BY WILLIAM A. FAIRBURN.

The S.S. Winifred, which has just been completed by the Bath Iron Works, of Bath, Maine, is a very interesting vessel. She is the first steel tramp steamer designed and built by Americans of American material to sail under the American flag. To the enterprise of Messrs. Miller, Bull and Knowlton, of New York, managing owners of the New York and Porto Rico S.S. Company, is due the existence of this fine ship. By those who have examined her she is conceded to be superior to any cargo steamship of her size and type afloat.

The Winifred is designed as a cargo carrying, money earning steamship, and thus her model is as full as it is possible to make it, without sacrificing to any great extent economy of propulsion. The coefficient of displacement is more than .8, and the displacement is so proportioned fore and aft that the entrance and run below water are remarkably fine and easy, the midship section being almost rectangular in shape.

The following are the general dimensions of the Winifred:

Length over all	304 ft. 3 in.
Length L. W. L.	290 ft. 0 in.
Beam molded	42 ft. 0 in.
Depth molded center	25 ft. 10½ in.
Depth molded side	25 ft. 0½ in.
Load draught	20 ft. 0 in.

BROADSIDE VIEW OF OCEAN-GOING CARGO S.S. WINIFRED, WHEN LIGHT.

Least freeboard at load draught	5 ft. 0½ in.
Height between decks	8 ft. 6 in.
Gross tonnage	2,456.48 tons.
Net tonnage	1,455.83 tons.
Tonnage under decks	2,417.94 tons.
Registered length	283.5 ft.
Registered beam	42 2 ft.
Registered depth	22 1 ft.

The Winifred is a two deck steamer with topgallant forecastle, bridge and poop decks, and closed in houses connected by steel bulwarks 3 ft. 3 in. high. The distance between the main and bridge deck is 7 ft. 3 in. The vessel has a

*A brief description of the Winifred was published in our issue of January last. Since that time, however, certain modifications of design were decided upon and this will account for any apparent differences in the figures then published and those contained in this article.—Editor.

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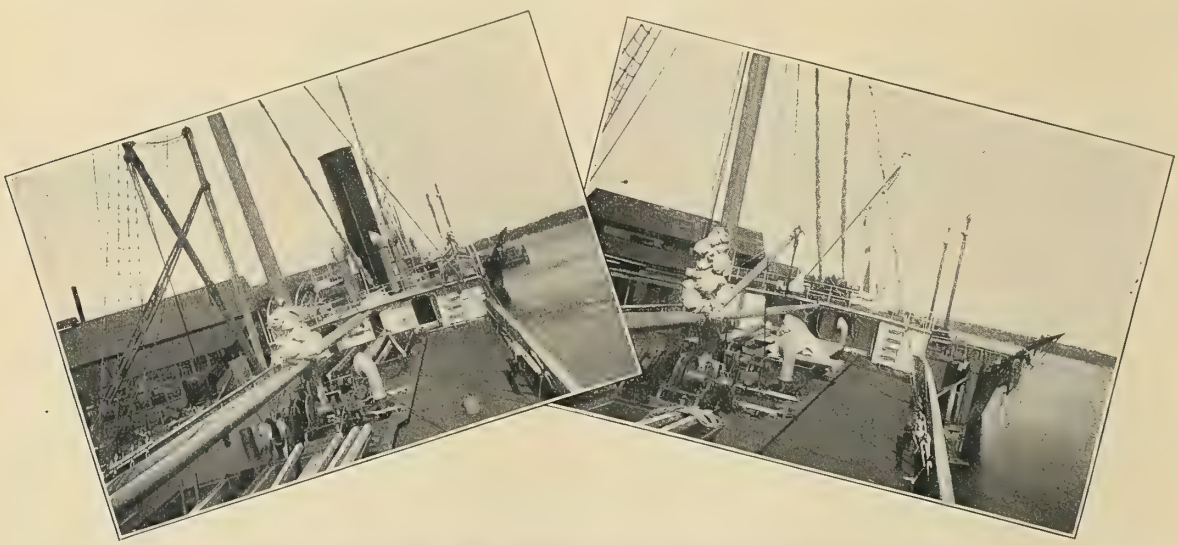
neat pleasing sheer and a high seaworthy bow, the extreme freeboard at the bow including the forecastle being nearly 18 ft. when loaded. She has a parallel middle body of about 120 ft., a deadrise of 12 in. and a tumble home of about 3 in. A double bottom runs from the collision to the after peak bulkhead. It is constructed on the McIntire system with eleven continuous fore and aft girders resting on floors 24 in. deep. The tank is about 4 ft. deep, and the total capacity of the water bottom is 800 tons. The vessel has six complete watertight bulkheads running to the weather deck, and there are also two partial transverse bulkheads and two fore and aft coal bunker bulkheads running the complete length of the machinery spaces. The holds and 'tween decks are ceiled with 2 1-2 in. yellow pine. The lower deck is planked with 3 1-2 in. yellow pine over steel bulb tee beams, stringers and tie plates. The main deck is constructed of heavy steel plates laid over bulb angle beams 24 in. apart, and this deck is sheathed with 2 1-2 in. white pine only in the living spaces. The forecastle, poop, and bridge decks are planked with 3 in. white pine, laid over bulb angle beams, stringers and tie plates. In the forecastle are neat pipe berths for nine sailors and nine firemen, also a large carpenter's shop, water closet, wash room, vegetable lockers, ice room and oil room. In the midship house are the engine and fire room hatches, galley, pantry, state rooms for three engineers, two mates, two quartermasters, cook and steward, a large room for the captain and two passenger state rooms. There are two mess rooms for the officers in the after part, and a large saloon occupies the space at the forward end of the house, it being beautifully finished in sycamore and cherry.

The space in the poop has been fitted up for the accommodation of eighteen passengers, as it is the intention of the owners at present to run the vessel frequently to Porto Rico. Here there are nine roomy double berth state rooms with saloon, pantry and waiters' rooms. A large chart house and captain's state room is on the forward bridge deck with a bridge overhead and so arranged that the vessel can be steered either from the bridge or the chart house by hand or steam.

The Winifred has two steel pole masts with four 40 ft. cargo booms on each mast. The facilities on board for the handling and stowage of cargo are very complete. She has four unusually large hatches, viz., 26 ft. by 14 ft. at the main deck, and 26 ft. by 16 ft. at the lower deck. She is provided with leg of mutton steadying sails, the total sail area being 5,655 sq. ft.

Four boats are carried on the bridge deck; three of them are 22 ft. metallic double-ended life boats, the fourth being an 18 ft. working boat. The total cubical capacity of the four boats is 725 cu. ft., which means a carrying capacity of seventy-two men. The total number of berths on the vessel is fifty-seven, and of this number twenty-two are for the accommodation of passengers.

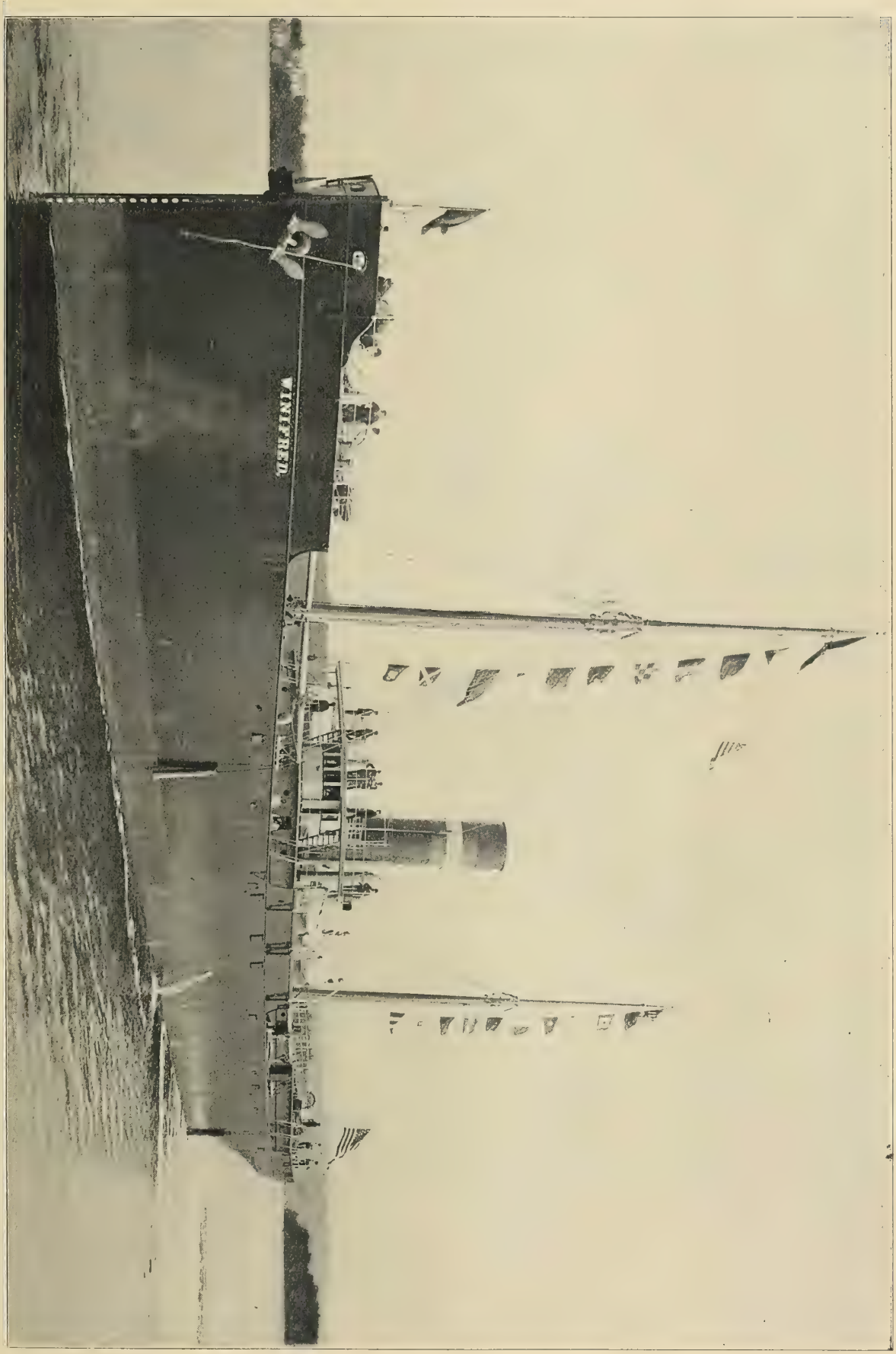


DECK VIEWS ON THE NEW CARGO STEAMSHIP WINIFRED.

The vessel has three Baldt stockless bower anchors with a weight of 4,800 lbs. each, also one stream and two Kedge anchors; 240 fathoms of 1 7-8 in. stud link chain cable and 90 fathoms of 1 in. stream chain. A Hyde steam windlass is located on the forecastle. There are four Williamson winches on the main deck, one at each hatch, and a Williamson steam steerer is located in the engine room.

The bunkers alongside the engine room are reserve bunkers, and will be often used for the stowage of cargo.

The machinery consists of a vertical triple-



AMERICAN STEEL OCEAN-GOING CARGO-CARRYING STEAMSHIP, THE WINIFRED—BUILT AND ENGINED BY THE BATH IRON WORKS, BATH, ME.

Photographed by F. V. Moody, Bath, Me.

expansion engine with cylinders 20 1-2 in., 34 in. and 55 in. dia. and 36 in. stroke designed to indicate about 1,100 I. H. P. at 100 rev. The condenser forms part of the engine framing, the cooling surface being 1,476 sq. ft. A cast iron box column on each end and an inverted Y column in the center form the support for the cylinders at the working side of the engine. The high pressure cylinder is located forward, and the low pressure aft. The high and intermediate pressure cylinders have piston valves, the latter being fitted on the side, and the low pressure cylinder has a slide valve. The intermediate and low pressure pistons are fitted with tail rods, Most of the pumps are worked from the main engine. Steam is supplied at 165 lbs. pressure by two steel Scotch boilers (single ended) of these dimensions:

Length of boiler	12 ft. 3 in.
Mean dia. boiler	12 ft. 5 in.
Distance between tube sheets	8 ft. 3 in.
Ordinary tubes 261 = 2½ in. ext. dia., No. 12 B. W. G.	
Stay tubes 52 = 2½ in. ext. dia., No. 6 B. W. G.	
Furnaces	3 Morison suspension
Inside dia. of furnaces	42 in.
Grate surface	70 sq. ft.
Length of grates	6 ft.
Tube heating surface	1,755 sq. ft.
Total heating surface	2,033 sq. ft.
Ratio G S to H S	29.04

A Scotch donkey boiler is located on the lower deck directly over the main boilers. It has a length of 9 ft. 7 1-2 in. over all, and a diameter of 6 ft. 7 1-2 in. There is one 39 in. furnace fitted with a grate 5 ft. 7 in. long. The total heating surface is 539 sq. ft., and the grate surface 17.6 sq. ft., a ratio of 30.62 to 1.

The Winifred has an ash ejector, located in the fire room. A large fan has been fitted to ventilate the stoke hole and assist the draft, but on her steam trials the fan was not used, and yet the temperature in the fire room was only 80 deg. F. and that of the engine room only 78 deg. F., a remarkable low temperature, as these compartments are well below deck.

Her endurance or radius of action is 4,500 knots with full bunkers and 2,500 knots when the reserve bunkers are used for the stowage of cargo. The propeller fitted on the Winifred during her speed test was of the following dimensions:

Diameter	13 ft. 0 in.
Pitch up to 4 ft. radius	10 ft. 11 in.
Pitch at 5 ft. 6 in. radius	11 ft. 10½ in.
Blades	4
Length of hub	23½ in.
Dia. of hub	19 in.
Max. width of blades	33 in.
Projected blade area	43.5 sq. ft.
Developed blade area	50.5 sq. ft.
Disc area	132.7 sq. ft.
Material	Cast Iron.

The following figures for capacity will be of interest:

Capacity of holds for bales	168,650 cu. ft.
Capacity of holds for grain	183,118 cu. ft.
Dead weight carried at load draft	3,800 tons.
Coal bunker capacity	450 tons.
Capacity of reserve bunker	8,600 cu. ft.

STEAM TRIALS OF S.S. WINIFRED.

The steam trials of the Winifred were conducted by the Bath Iron Works on September 26 off Southport, Maine. The vessel steamed for five hours at two-thirds and full power. She had been laying at the wharves of her builders for eighty days, and therefore her bottom was only in fair condition for a speed test. The Winifred carried on trial a load of about 600 tons, and her propeller was 19 in. out of water. This was the first time she had left the wharf under her own steam.

Following are the official figures of the technical staff which conducted the speed test:

Trial draught, forw'd	6 ft. 5 in.
Trial draught aft	12 ft. 3 in.
Trial draught, mean	9 ft. 4 in.
Speed in knots	11.25
Slip per cent	10.53
Disc area, wheel on trial, sq. ft.	123.7
Area mid section ÷ disc area	2.95
Projected blade area, wheel on trial, sq. ft.	40.5
Developed blade area, wheel on trial, sq. ft.	48
Revolutions	101.3
Max. piston speed, ft.	644
Steam pressure, boilers, lb.	160
Steam pressure, I. P. rec., lb.	40
Steam pressure, L. P. rec., lb.	4
Vacuum, in	21.5
M. E. P. H. P. Cyl., lb.	79
M. E. P. I. P. Cyl., lb.	22.42
M. E. P. L. P. Cyl., lb.	6.75
Equivalent referred to L. P. Cyl.	26.32
I. H. P. H. P. Cyl.	509
I. H. P. I. P. Cyl.	390
I. H. P. L. P. Cyl.	313
I. H. P. total	1,212
Indicated thrust, lb.	31,380
Indicated thrust, per sq. in. developed blade area, lb.	4.54
Indicated thrust, per sq. ft. projected blade area, lb.	5.38
Heating surface in sq. ft. per I. H. P.	3.35
Cooling surface in sq. ft. per I. H. P.	1.18
I. H. P. per sq. ft. grate surface, nat. draft.	8.66

A run over the measured mile gave a speed of 11.16 knots against the tide with 1,207 I. H. P., and against a very strong wind—which had a very detrimental effect on this high sided boat, the freeboard on trial being over 30 ft. forward—the speed on another occasion was 10.8 knots with about 1,100 I. H. P. The average cruising speed was over 10 1-4 knots, with 96 rev. and 900 I. H. P. Throughout the trial the machinery was never once forced, and no attempt was made to obtain high power or speed, but the trial proved beyond a doubt that the machinery is capable of developing at least 1,400 I. H. P. when assisted by the fan, and that the sustained power will be at least 1,100 I. H. P. The rate of speed of the Winifred when light, with assisted draft will be 12 knots, and when deeply loaded at sea 10 1-2 knots. She has therefore proved herself to be one of the fastest vessels of her size and type afloat.

CONSTRUCTION OF THE NEW U. S. COMPOSITE GUNBOATS WITH A COMPARISON OF THEIR PERFORMANCES.

The six cruising gunboats, officially known as numbers 10 to 15, authorized by act of Congress and approved March 2, 1895, marked a new era in the constructive practice of our modern navy, and increased to nine our fleet of small craft especially designed for police duty in the rivers and shallow estuaries of China, and in the waters of the revolutionary Central and South American Republics.

These vessels are of composite construction, advocated by Chief Constructor Hichborn, and the strong features of their design are great sea keeping power, with minimum running expenses and initial cost, good fighting ability on a small displacement, good sea speed without constant docking, for the copper sheathing will prevent fouling, and, in the case of numbers 10 to 13 remarkable endurance and cruising power, for these four vessels have full sail power. Gunboats 10 to 13 are the "Annapolis," "Vicksburg," "Newport" and "Princeton," respectively. They are of the single-screw type with full sail power. The "Annapolis" was built by Lewis Nixon at the Crescent Shipyard, Elizabethport, N. J. The contract was signed November 20, 1895; she was launched December 23, 1896, and she steamed on her official trial April 22, 1897. The "Vicksburg" and "Newport" were built by the Bath Iron Works, of Bath, Me.; the contract for these vessels was signed November 15, 1895. They were both launched together, December 5, 1896, and the official speed trials took place May 29 and May 27, 1897, respectively. The "Princeton" was contracted for by J. H. Dialogue & Sons, Camden, N. J., on November 20, 1895. Her keel was laid six months later, and the construction of this vessel was so slow that she was only comparatively recently turned over to the government by her builders.

The hulls and general characteristics of these four vessels are supposed to be identical. The following are their general dimensions and particulars of form:

Length over all	204 ft.
Length L. W. L	168 ft.
Beam	36 ft.
Ratio of L. to B	4.66
Depth to spar deck	22 ft. 3½ in.
Mean draught	12 ft.
Normal displacement	1,010 to 1,017 tons
Tons per inch of immersion at L. W. L	10.73
Area of immersed mid-section	356 sq. ft.
Area of load-water plane	4,510 sq. ft.
Metacentric height—G. M.	4.07 ft.
Co-efficient of displacement	.485
Prismatic co-efficient	.59
Mid-section co-efficient	.82
L. W. plane co-efficient	.74

These vessels, as before mentioned, are of composite construction, with steel plating above and wood planking below the water line. They have a flush spar deck with hammock berthing amidship, a gun deck with offices and cabins at the after end, and a berth deck forward and aft of the machinery spaces. There is a double bottom under the engines and boilers which can be used for the stowage of fresh water. The bulkheads on ten frames are made watertight below the gun deck, as are also the coal bunkers, store rooms and hold. There is no protective deck, but the coal bunkers which surround the machinery spaces extend to the gun deck, which is a good distance above the load water line, and give good protection when full. There is a trimming tank at each extremity of these vessels and each is divided into twenty-eight watertight compartments. These vessels are barkentine rigged, the area of the nine principal sails being 11,253 sq. ft. They each carry seven boats, including a steam cutter. The main battery consists of six 4-in. R. F. guns, and the secondary battery is made up of four 6-pounders and two 1-pounder R. F. guns. There are no torpedo tubes. The contracts required an average speed of 12 knots for four consecutive hours, subject to a penalty at the rate of $10,000 per knot for a less speed. There was no premium for excess of speed or I. H. P. As the "Princeton's" trial cannot be recorded in this article we will neglect this vessel and briefly describe the machinery of her three sisters.

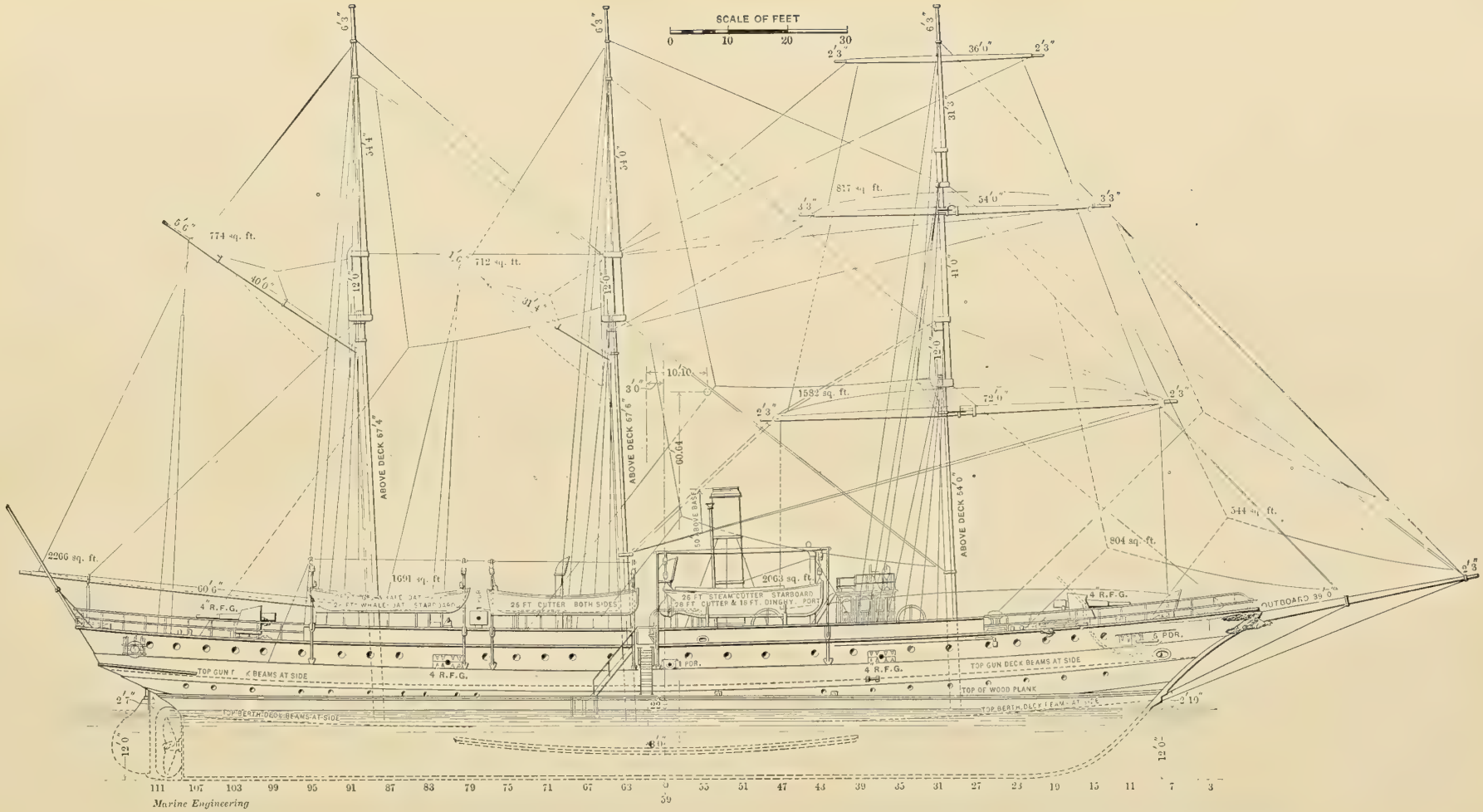
The "Newport" and "Vicksburg" have two single-ended horizontal return fire-tube boilers. each with two corrugated furnaces:

Length	10 ft. 6 in.
Diameter	10 ft. 6 in.
Diameter of furnaces	{ Min., 36 in. Max., 39 in.
Length of grate	6 ft. 6 in.
Number of ordinary tubes	132
Number of stay tubes	64
Outside diameter of all tubes	2¾ in.
Length between tube sheets	7 ft. 6 in.
Tube-heating surface	1,058.4 sq. ft.
Total heating surface	1,262 sq. ft.
Grate surface	39 sq. ft.
Ratio grate surface to H. S	1 to 32.06
Area through tubes	6.23
Normal steam space	166 cu. ft.
Total H. S. of two boilers	2,524 sq. ft.
Total G. S. of two boilers	78 sq. ft.

The forced draft is supplied by two Sturtevant blowers which discharge under the brick wall into the back of each ash pan.

There are eight coal bunkers, the total capacity being 240 tons.

The "Newport" and "Vicksburg" have each a single screw engine of the vertical triple-expansion type, designed to indicate 800 I. H. P. at 150 revolutions per minute. It is arranged in the usual manner with the H. P. cylinder forward, the cranks being 120 deg. apart and following in the order H. P., I. P. and L. P., the cranks turning to port from the top center. The cylinders are jacketed on top and sides. The H. P. cylinder has a piston valve whilst the I. P. and L. P. cylinders have double ported slide valves. The valve gear is the ordinary Stephenson link-motion with double bar links. The condenser is separate from the engine and the air pump is worked from the L. P. crosshead.



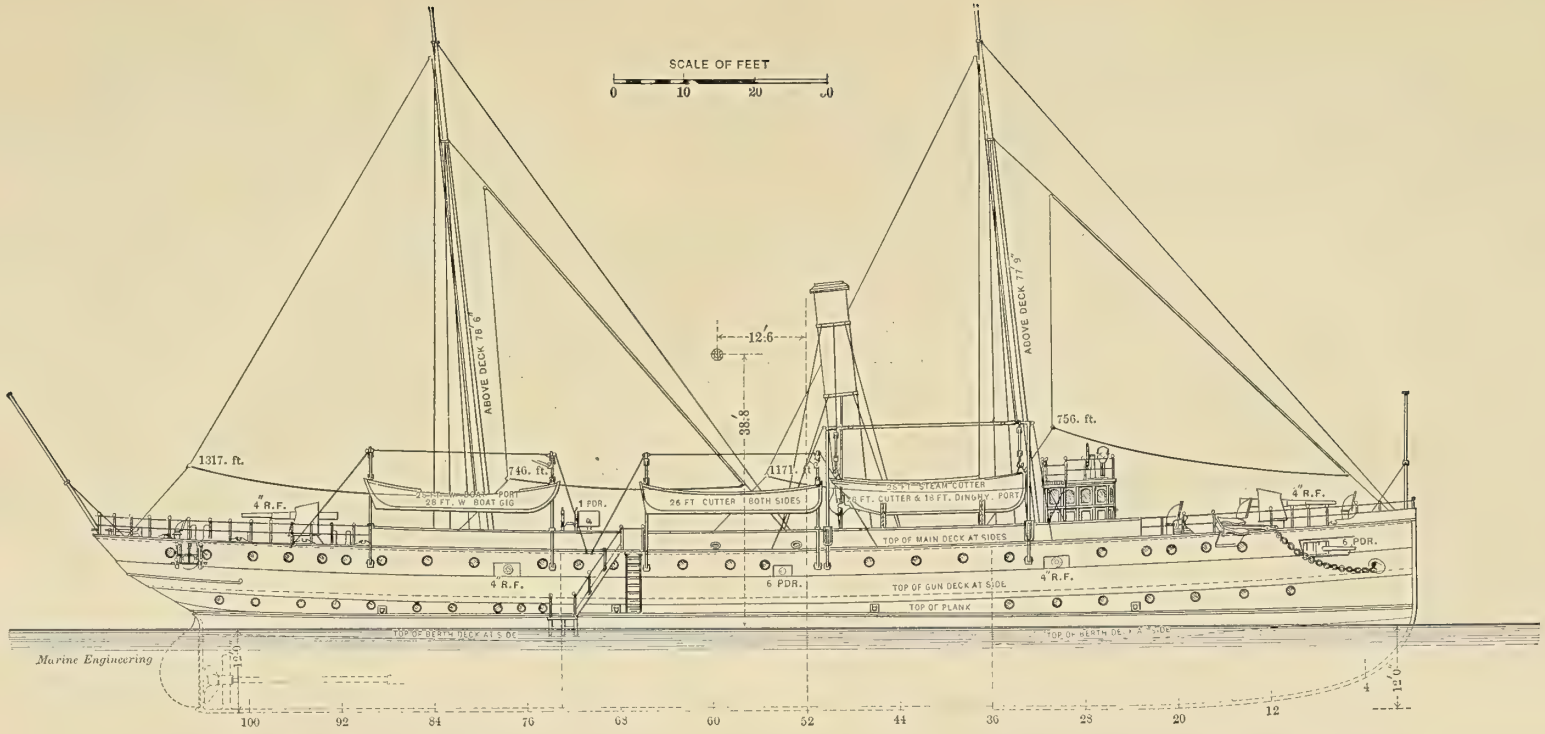
SAIL PLAN OF THE U. S. COMPOSITE GUNBOATS 10 TO 13—ANNAPOLIS, VICKSBURG, NEWPORT AND PRINCETON.

The following are some of the principal dimensions and particulars of these engines:

Diameter of cylinders	15¼, 23½, 36 in.
Stroke	30 in.
Ratio of net areas of pist ns H. P. to I. P	5.57
Propeller	Left-handed, three-bladed, bronze
Diameter of propeller	10 ft.
Pitch "Vicksburg"	10.627 ft.
Pitch "Newport"	10.453 ft.
Condenser	Cylindrical steel plate, bronze ends
Cooling surface	1,118 sq. ft.
Length between tube sheets	7 ft. 3 in.
Number of tubes	942
Auxiliary condenser	150 sq. ft.

The auxiliary machinery includes an electric plant, ventilation system, Hyde steam windlass, Hyde double hoisting engine, Williamson steering engine and workshop machinery.

The machinery of the "Annapolis" consists of a vertical single screw triple-expansion engine with cylinders 15 in., 24 1-2 in. and 40 in. dia. and 28 in. stroke. This engine was designed to



SAIL PLAN OF THE U. S. COMPOSITE TWIN-SCREW GUNBOATS NOS. 14 AND 15—WHEELING AND MARIETTA.

develop over 800 I. H. P. when running at 160 rev. with a steam pressure of 200 lbs. at the boilers. The ratio of net area of pistons H. P. to L. P. = 7.11. The propeller is solid four-bladed, bronze, true screw 9 ft. 6 in. dia. and 11 ft. pitch. The condenser forms part of the engine framing and is of cast iron with 124.1 sq. ft. of cooling surface. The auxiliaries are very similar to those fitted on gunboats Nos. 11 and 12. The "Annapolis" differs, however, from the Bath built sisters in her boiler plant. She is fitted with two Babcock & Wilcox water-tube boilers of these dimensions:

Length	11 ft. 7 in.
Width	9 ft. 6 in.
Height	11 ft.
Boiler-heating surface	1,575 sq. ft.
Heater H. S.	235 sq. ft.
Grate surface	49 sq. ft.
Total H. S. two boilers	3,620 sq. ft.
Total G. S.	98 sq. ft.
Ratio G. S. to H. S	1 to 37

Gunboats Nos. 14 and 15 are the "Wheeling" and "Marietta." They are composite twin-screw gunboats of 12 knots speed, and fitted only with steadying sails. They were built by the Union Iron Works, of San Francisco. The contract for these vessels was signed November 26, 1895. The keels were laid in April of the following year, and they were launched together March 18, 1897; the vessels steaming on their official trials May 29 and May 26, 1897, respectively, or exactly the same time as the two Bath built single-screw gunboats.

The general arrangement and construction of the hulls of these vessels closely resemble the

gunboats previously described. The following are the principal dimensions and features of the hulls of the "Wheeling" and "Marietta":

Length over all	189 ft. 7 in.
Length L. W. L.	174 ft.
Beam	31 ft.
Ratio of L. to B	5.12 to 1
Depth at side	22 ft. 7¾ in.
Mean draught	12 ft.
Displacement	996 tons
Tons per inch immersion at L. W. L.	10.13
Area of mid-section immersed	338 sq. ft.
Area of L. W. plane	4,284 ft.
Co-efficient of displacement	.508
Mid-section co-efficient	.858
L. W. P. co-efficient	.724
Wetted surface	6,495 sq. ft.

The hulls of these vessels below the main deck are divided into 42 watertight compartments, including the double bottom.

The twin-screw engines are of the vertical triple-expansion type, placed in a common compartment with the H. P. cylinder forward. These engines were designed to develop 400 I. H. P. each when running at 200 rev. with 180 lbs. of steam in the boilers. The following are a few of the most important dimensions and particulars of the engines, etc.:

Diameter of cylinders	12, 18 and 28 in.
Stroke	18 in.
Ratio of net area of pistons H. P. to L. P	5.93
Propeller	Three-bladed, solid bronze
Hand	Starboard left and the port right
Diameter of propellers	6 ft. 9 in.
Pitch	7 ft. 3 in.
Condensers	Composition, oval section
Length of tubes of condensers	8 ft. 6 in.
Number of tubes	404
Cooling surface each condenser	552 sq. ft.
Auxiliary condenser	4 ft 7 in. long
Diameter auxiliary condenser	18 in.
Cooling surface of auxiliary condenser	150 sq. ft.

The "Wheeling" is fitted with two single-ended horizontal cylindrical steel boilers:

Length	10 ft. 6 in.
Diameter	10 ft. 6 in.
Furnaces (two)	Min. dia., 36 in. Max. dia., 40½ in.
Number of ordinary tubes	130
Number of stay tubes	64
Diameter of all tubes outside	2¾ in.
Length between tube sheets	7 ft. 6 in.
Heating surface each boiler	1,254 sq. ft.
Grate surface each boiler	30 sq. ft.
Total heating surface, two boilers	2,508 sq. ft.
Total G. S., two boilers	60 sq. ft.
Ratio H. S. to G. S	41.3
Area through tubes	12.34 sq. ft.

Forced draft is fitted on the well-known Howden system.

The original design of the "Marietta" and also that of the "Annapolis" called for two cylindrical boilers similar to those installed in the "Wheeling," but at the request of the contractors two Babcock & Wilcox water-tube boilers were substituted. The boilers in the "Marietta" are exactly the same as those placed in the "Annapolis," as previousy described. The "Marietta" carries 247 tons of coal in her bunkers and the "Wheeling" about the same. The gunboats "Newport," "Vicksburg," "Wheeling" and "Marietta" were officially tried on the standardizing screw method. By this method the vessels are run over a certain measured base and curves of I .H. P. revolutions and speed are accurately plotted. The vessels then steam at sea for a period of four hours, and the mean number of revolutions being obtained for this period the speed corresponding to this number of revolutions can be readily obtained. It is, of course, necessary that the draught and trim of the vessel is the same on the progressive trial on the base as it is on the sea run. The "Newport" and "Vicksburg" had progressive speed trials on the Bath Iron Works measured nautical mile course off Southport, Me., it having been officially measured; for the four hours sea trial the vessels were headed out to sea. The "Wheeling" and "Marietta" were tried over a measured base of 6,138 ft. off Bluff Point in San Francisco Bay. The "Vicksburg" and "Newport" were tried under ordinary weather conditions. The progressive runs of the "Wheeling" were made at low speed during a comparative calm, whilst those of the "Marietta" were made in a fresh breeze; at the higher speeds the conditions were exactly reversed.

PROGRESSIVE SPEED TRIALS OF U. S. S. VICKSBURG.

Run.	Speed Knots	Rev. per M.	Total I.H.P.
1	12.676	144.4	1,103.40
2	12.456	144.95	1,062.22
3	12.544	142.5	1,032.61
4	12.361	142.8	1,030.13
5	12.06	134.38	866.58
6	11.746	132.68	825.33
7	11.603	127.27	722.54
8	11.268	127.14	710.25
9	10.666	115.55	535.71
10	10.375	115.21	524.36

PROGRESSIVE SPEED TRIALS OF U. S. S. NEWPORT.

1	11.755	141.65	1,008.71
2	12.51	138.89	951.13
3	11.58	136.82	925.84
4	12.326	138.93	941.35
5	11.613	138.92	959.55
6	12.255	136.85	905.04
7	11.193	131.8	839.09
8	11.379	127.2	688.77
9	10.056	116.06	552.07
10	10.810	117.08	564.34

PROGRESSIVE SPEED TRIALS OF U. S. S. WHEELING.

1	8.719	117	133.12
2	5.893	125	168.76
3	10.919	158	314.44
4	7.956	157	306.9
5	11.506	179	451.93
6	9.469	178	473.06
7	11.096	177	459.99
8	9.989	181	477.04
9	10.242	199	650.82
10	12.582	200	648.94
11	9.989	199	650.06
12	12.713	203	689.77
13	11.292	224	953.89
14	13.825	228	991.38
15	11.654	228	1,022.25
16	13.669	227	1,003.63

PROGRESSIVE SPEED TRIALS OF U. S. S. MARIETTA.

1	5.568	118	136.89
2	8.062	112	127.90
3	7.074	143	243.30
4	10.10	149	280.06
5	12.452	184	514.62
6	8.89	182	475.83
7	12.242	180	461.27
8	8.906	181	497.78
9	13.126	204	677.81
10	10.789	210	749.73
11	13.080	210	741.44
12	11.222	209	731.30
13	12.452	229	981.55
14	13.367	231	1,024.52
15	12.939	236	1,069.88
16	13.032	231	1,059.01

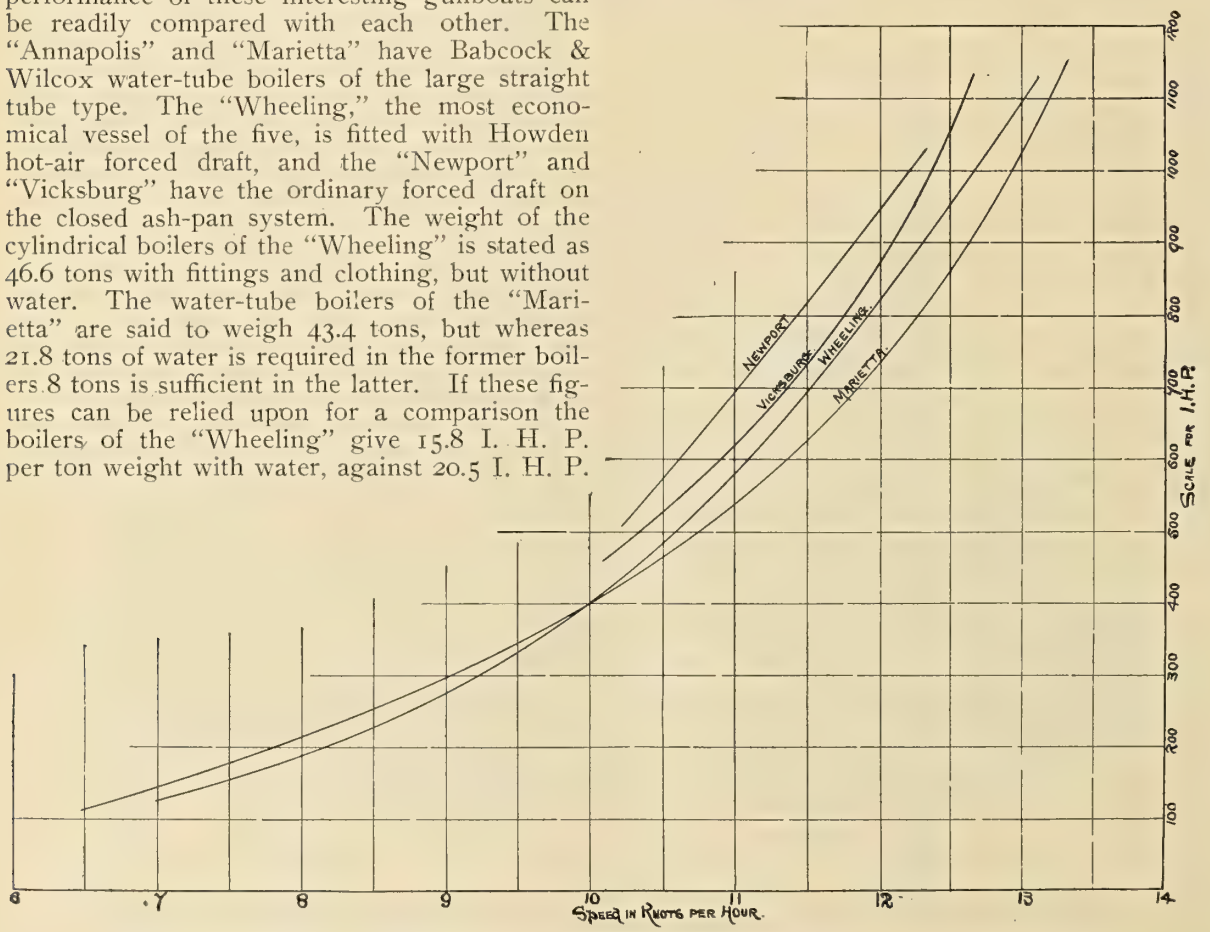
BROADSIDE VIEW OF THE ANNAPOLIS CLASS OF U. S. COMPOSITE GUNBOATS.

BROADSIDE VIEW OF THE WHEELING CLASS OF TWIN SCREW COMPOSITE GUNBOATS.

CONTRACT TRIAL DATA, FOUR HOURS' SEA RUN, U. S. COMPOSITE GUNBOATS.

	Newport	Vicksburg.	Annapolis.	Wheeling.	Marietta.
Mean trial draught, feet	11.8½	11.7¾	11.5	12.0⅜	11.11½
Mean trial displacement, tons	972	964	943	1,000	991
Area mid-section, sq. ft	344	342	333	352	349
Area wetted surface, sq. ft	7,060	7,040	6,980	7,300	7,250
Speed, knots	12.29	12.71	13.172	12.88	13.02
Slip, per cent	16.49	17.39	17.3	22.2	21.5
$\frac{D^{\frac{2}{3}} \times V^3}{I.H.P.}$	183.9	181.5	179.76	202.2	213
$\frac{A \times V^3}{I.H.P.}$	644.8	636.3	622.49	747.8	711.6
I. H. P. per 100 square feet W. S	14.03	15.68	17.51	14.5	14.2
Revolutions, mean	142.68	146.57	146.76	231.4	231.8
Piston speed, feet	713.40	733.85	684.88	694.2	695.4
Steam pressure boilers	182	186	224.7	182	173.6
Vacuum, inches	25.5	26.3	24	26.7	26.25
Air pressure in ash pan, inches	.95	.97	.9	.78	.36
M. E. P. referred to L. P. cylinder	45.04	48.57	46.47	42.74	40.5
I. H. P. main engines	976	1,084	1,207	1,051	1,024
I. H. P., collective	1,009	1,118	1,227	1,080	1,054
Indicated thrust, pounds	16,021	18,513	24,685	20,625	20,102
Indicated thrust per square inch of developed blade area	4.75	5.5	5.72	4.2	4.1
Square feet of cooling surface per I. H. P	1.13	1.01	1.02	1.04	1.07
Square feet of H. S. per I. H. P	2.50	2.26	2.95	2.32	3.48
I. H. P. per square foot G. S	12.93	14.34	12.52	18	11.2
I. H. P. per ton machinery penalty weight	8.89	9.85	9.35	9.34	10.15
Coal burnt per hour, pounds	2,065	2,375	3,580	1,855.5	2 300
Coal per I. H. P. per hour, pounds	2.05	2.12	2.91	1.72	2.18
Coal per square foot G. S., pounds	26 48	30.45	36.53	30 92	23.47
Quality of coal	Pocahontas	Pocahontas	Pocahontas	Good Harris	Navigation

The coal consumption test of the "Annapolis" was not very carefully conducted and the above figures represent the return run over a 24-mile course off Bridgeport, Conn. These results should be questioned. The foregoing figures are arranged in tabular form so that the trial performance of these interesting gunboats can be readily compared with each other. The "Annapolis" and "Marietta" have Babcock & Wilcox water-tube boilers of the large straight tube type. The "Wheeling," the most economical vessel of the five, is fitted with Howden hot-air forced draft, and the "Newport" and "Vicksburg" have the ordinary forced draft on the closed ash-pan system. The weight of the cylindrical boilers of the "Wheeling" is stated as 46.6 tons with fittings and clothing, but without water. The water-tube boilers of the "Marietta" are said to weigh 43.4 tons, but whereas 21.8 tons of water is required in the former boilers 8 tons is sufficient in the latter. If these figures can be relied upon for a comparison the boilers of the "Wheeling" give 15.8 I. H. P. per ton weight with water, against 20.5 I. H. P. per ton weight of the water-tube boilers. The accompanying speed curves graphically show the relative performances of the four vessels which were given progressive trials, these results having been plotted from the figures given in the proceeding tables.



SPEED CURVES SHOWING THE PERFORMANCES ON PROGRESSIVE TRIALS OF FOUR U. S. COMPOSITE GUNBOATS.

HIGH PRESSURE AT SEA WITH SOME CONSIDERATION OF TYPES OF BOILERS.*—VI.

BY W. R. CUMMINS.

[*Last Installment.*]

In order to compare the turning moments of the different types of engine, both three and four crank, Figs. 4 to 9 have been prepared. The different types of engine represented have all the same area of low-pressure cylinder or cylinders, the same stroke, number of expansions and revolutions. Also approximately the same mean pressure referred to the low-pressure cylinder. Hence the mean turning moment will be approximately the same for each type. The pressures have been taken from diagrams constructed to be as nearly like the actual diagrams as possible.

The inertia of the moving parts has been calculated on the assumption that the angular velocity of the crank shaft is constant. The weight of the moving parts has been proportioned to the initial load, and the pistons have been taken as of ordinary cast-iron design.

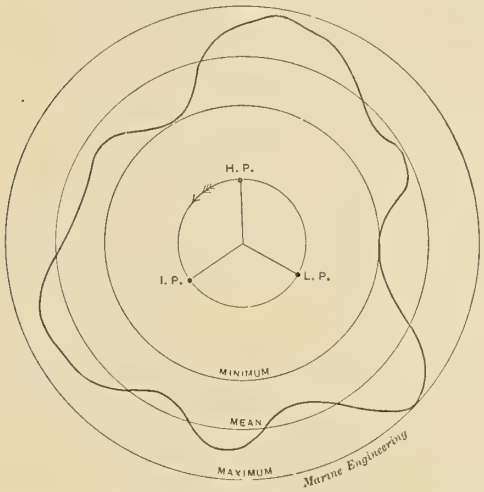


Fig. 4

3 Cylinder, 3 Stage.	Turning Moments.
15½ × 26½ × 49.	Maximum > Mean, 30 per cent.
Revs. = 75.	Minimum < Mean, 26 per cent.
Equal initial loads.	Total variation, 56 per cent.

From these diagrams we see that the engines which give the most equable turning moment are the four-cylinder two-stage and the four-cylinder four-stage, with a variation of 14 per cent above the mean turning moment and 34 per cent below for the two-stage, and 23 per cent above and 27 per cent below for the four-stage.

Taking into account all these facts as to initial load, cuts-off, drop and turning moment, it would appear that for ordinary work the three-cylinder three-stage type is the most suitable, if three cranks are to be used, as it has less total initial load, more equal cuts-off, less loss from drop, and a more equable turning moment than the two-stage three-cylinder type. If four cranks are desired, the most suitable arrangement for ordinary mercantile work is the four-stage four-cylinder arrangement, as it has less initial load, more equal cuts-off, less loss from drop and a more equable turning moment than the three-stage four-cylinder type.

Fig. 9 shows the disastrous effect on the turning moment with unequal initial loads. In the diagram shown the initial loads in each of the two low-pressure cylinders are one-half the load on the high-pressure and intermediate-pressure. The result is that the maximum turning moment is 39 per cent greater than the mean, and the minimum 60 per cent less than the mean, giving a total variation of 99 per cent.

For navy engines the two-stage four-cylinder type has many advantages to recommend it. It has less initial load than any of the other arrangements. The cuts-off are not equal, but with the fewer total expansions required by navy engines the cut-off in the low-pressure would be sufficiently late to give enough valve opening. The loss from drop is more than in the other types, but is not of such importance in the case of navy engines. The turning moment is more equable than any of the other types, and as the maximum moment is only 14 per cent more than the mean, whereas in the three-stage four-cylinder type with unequal initial loads it is 39 per cent more than the mean, it follows that the shafting may be reduced in size no less than 25 per cent. The arrangement is practically two compound engines, and in the event of damage to either of the cylinders or gear the engine affected could be shut off without interfering with the working

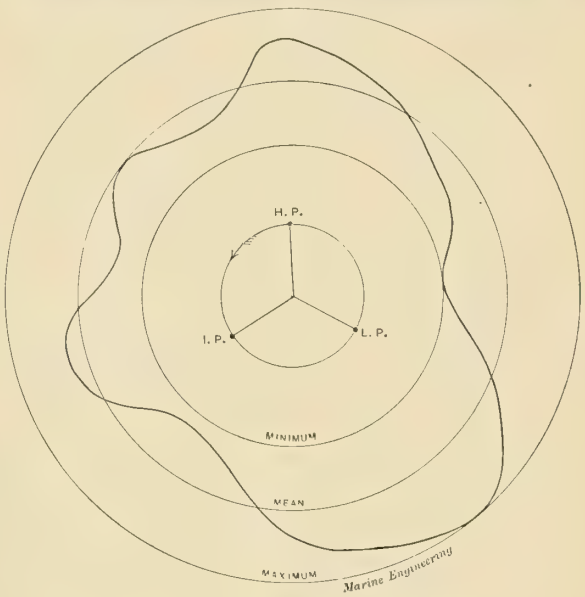


Fig. 5

3 Cylinder, 2 Stage.	Turning Moments.
15½ × 34½ × 34½.	Maximum > Mean, 33 per cent.
Revs. = 75.	Minimum < Mean, 29 per cent.
Equal initial loads.	Total variation, 62 per cent.

*From a paper read at the North-East Coast Institute of Engineers and Shipbuilders in Sunderland, England.

of the other. Still greater advantages could be obtained by using four cylinders of different size, to be used as a four-stage arrangement for cruising and as a two-stage arrangement for full power. In reference to the most suitable general arrangement of engine, the author stated that in the three-crank engine there is not much

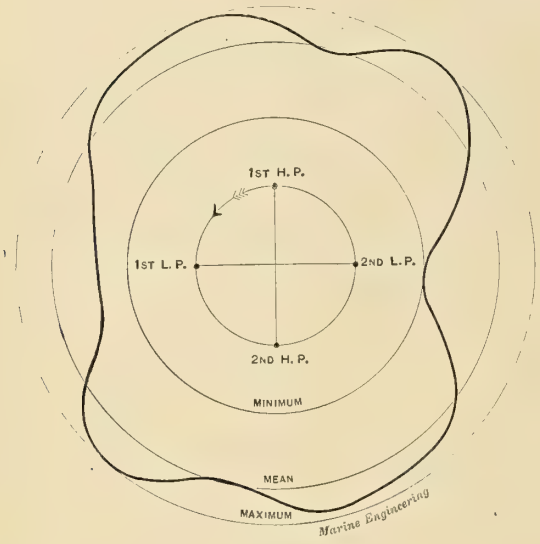


Fig. 6

4 Cylinder, 2 Stage.

$\overline{11 \times 34\frac{1}{2} \times 11 \times 34\frac{1}{2}}$.
Revs. = 75.
Equal initial loads.

Turning Moments.

Maximum > Mean, 14 per cent.
Minimum < Mean, 31 per cent.
Total variation, 45 per cent.

pressure aft; valve chests all looking forward, two short ends of crank shaft between high pressure and intermediate pressure; two long ends or a short and a long between intermediate pressure and low pressure; intermediate pressure eccentrics on couplings. (2) High pressure in center, intermediate pressure forward, and low pressure

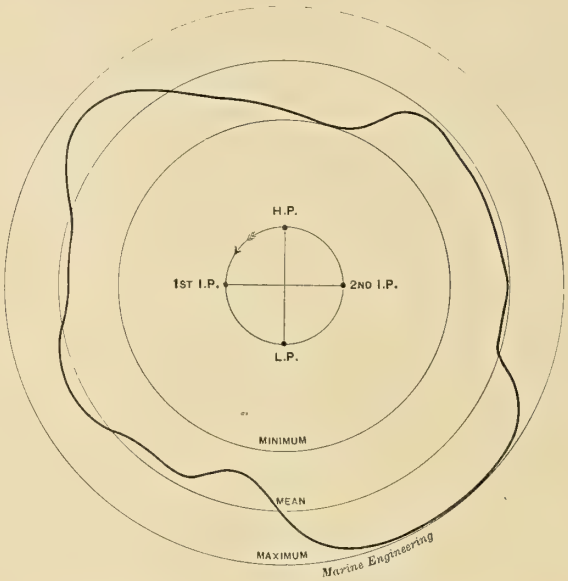


Fig. 7

4 Cylinder, 4 Stage.

$\overline{15\frac{1}{2} \times 22 \times 32 \times 49}$.
Revs. = 75.
Equal initial loads.

Turning Moments.

Maximum > Mean 23 per cent.
Minimum < Mean, 27 per cent.
Total variation, 50 per cent.

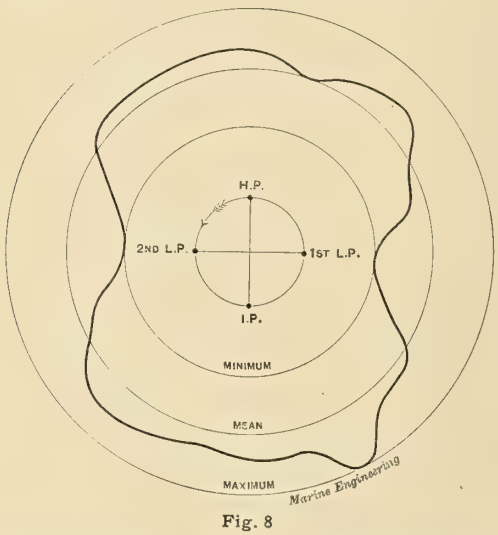


Fig. 8

4 Cylinder, 3 Stage.

$\overline{15\frac{1}{2} \times 25\frac{1}{2} \times 34\frac{1}{2} \times 34\frac{1}{2}}$
Revs. = 75.
Equal initial loads.

Turning Moments.

Maximum > Mean, 30 per cent.
Minimum < Mean 33 per cent.
Total variation, 63 per cent.

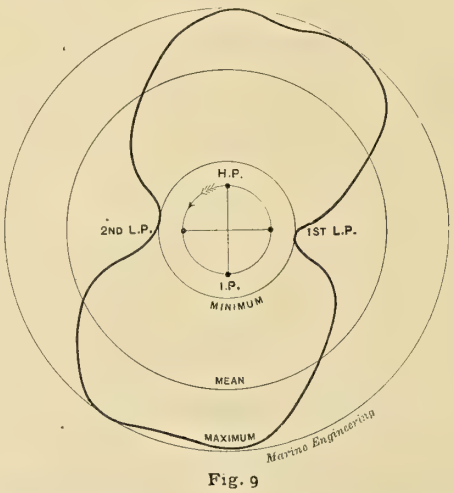


Fig. 9

4 Cylinder, 3 Stage.

$\overline{15\frac{1}{2} \times 25\frac{1}{2} \times 34\frac{1}{2} \times 34\frac{1}{2}}$.
Revs. = 75.
Unequal initial loads.

Turning Moments.

Maximum > Mean, 39 per cent.
Minimum < Mean, 60 per cent.
Total variation, 99 per cent.

to choose between the three typical designs into which the triple expansion engine with six bearings and three interchangeable cranks has fallen, viz.: (1) High pressure forward, intermediate pressure in center, and low

aft; high pressure piston valve and intermediate slide valve in one chest between the cylinders, low pressure slide valve forward of cylinder; short and long length of crank shaft between high pressure and intermediate pressure, also between in-

termediate pressure and low pressure; high pressure eccentrics on couplings; and (3) the Admiralty design, high pressure forward, intermediate pressure in center, and low pressure aft; high pressure valve forward, intermediate pressure valve forward, low pressure valve aft of cylinder; short and long lengths of crank shaft between high pressure and intermediate pressure, two short lengths between low pressure and intermediate pressure; no eccentrics on couplings.

In the four-crank engine the great object will be to save fore and aft space, and some endeavor should be made to reduce as far as possible the be off the center line of the engine, and if the first and second cylinders are fitted with piston valves, there is no reason why they should not be arranged in that manner. If the two after cylinders and the two forward cylinders have their cranks opposite one another, and if the cuts-off in each cylinder are equal, or nearly equal, then only two sets of valve gear are required, and they may be put together in the center of the engine, thus reducing the length of the reversing shaft to minimum. The slide valves of the two center engines would look towards one another, and the piston valves at the back of the engines

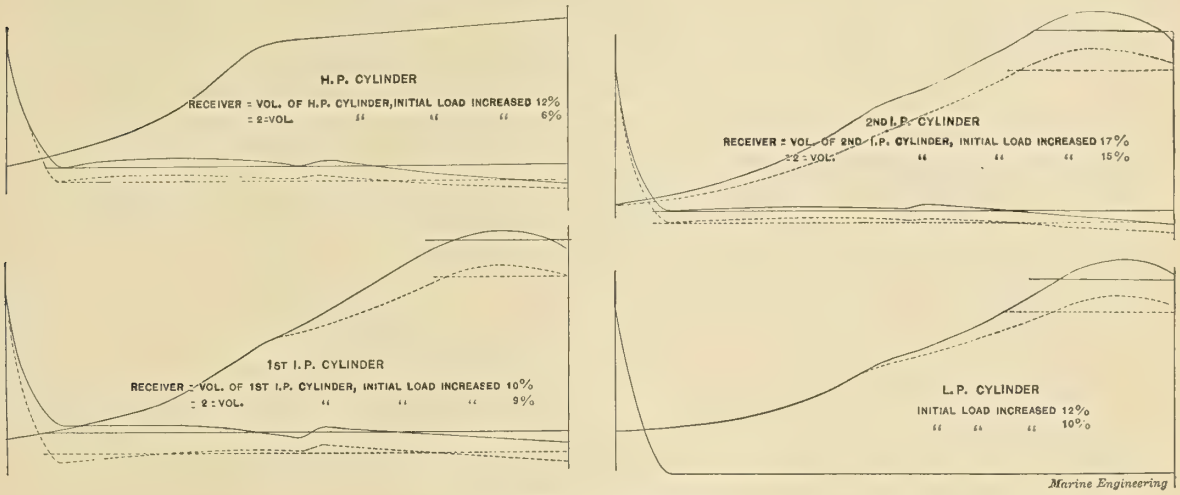

H. P. CYLINDER
RECEIVER = VOL. OF H.P. CYLINDER, INITIAL LOAD INCREASED 12%
= 2 = VOL. " " " 6%
2ND I. P. CYLINDER
RECEIVER = VOL. OF 2ND I.P. CYLINDER, INITIAL LOAD INCREASED 17%
= 2 = VOL. " " " 15%
1ST I. P. CYLINDER
RECEIVER = VOL. OF 1ST I.P. CYLINDER, INITIAL LOAD INCREASED 10%
= 2 = VOL. " " " 9%
L. P. CYLINDER
INITIAL LOAD INCREASED 12%
" " " 10%
Marine Engineering

Fig. 10.—Cranks at right angles.

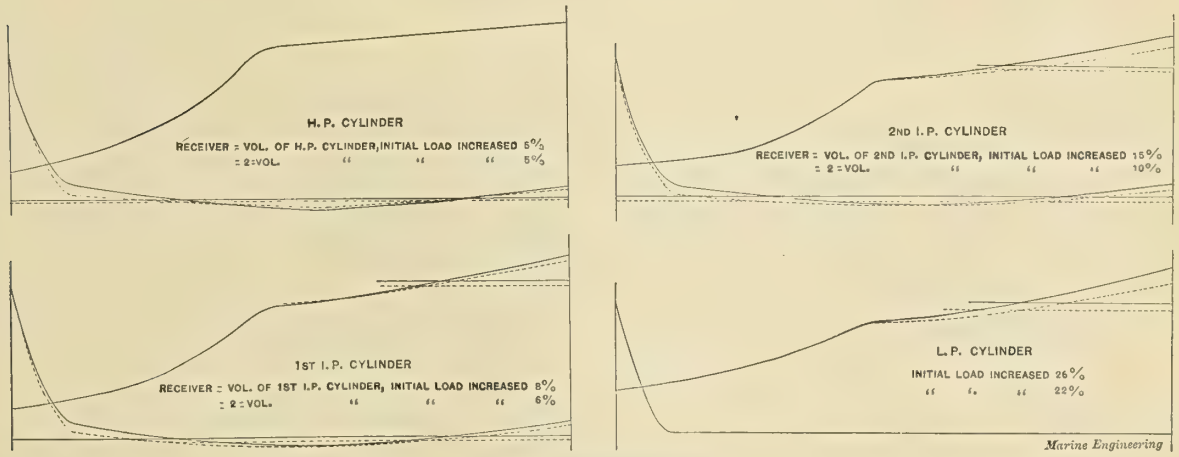

H. P. CYLINDER
RECEIVER = VOL. OF H.P. CYLINDER, INITIAL LOAD INCREASED 8%
= 2 = VOL. " " " 8%
2ND I. P. CYLINDER
RECEIVER = VOL. OF 2ND I.P. CYLINDER, INITIAL LOAD INCREASED 15%
= 2 = VOL. " " " 10%
1ST I. P. CYLINDER
RECEIVER = VOL. OF 1ST I.P. CYLINDER, INITIAL LOAD INCREASED 8%
= 2 = VOL. " " " 6%
L. P. CYLINDER
INITIAL LOAD INCREASED 26%
" " " 22%
Marine Engineering

Fig. 11.—Cranks opposite.

number of bearings and working parts. For instance, the crank shaft may be in two pieces only, interchangeable. By doing this six main bearings only are required, provided the two forward cranks and the two after cranks are arranged opposite one another, to take the greater part of the stress off the bearings between the two forward cylinders and the two after cylinders. Then, if the length of the engines is not to exceed the length of the three-crank engines, two of the valves must would be worked by rocking shafts, worked by levers and links from the slide valve rods. There is a prejudice against having valves off the center line of the engines, no doubt justified when a heavy slide valve is worked by an overhung pin; such an arrangement is bound to give trouble, owing to the want of stiffness of the overhung pin; but there can be no objection mechanically to a piston valve worked in that manner, provided there are no overhung pins. It should be men-

tioned here that the above arrangement, with the two opposite cranks separated only by the length of the main bearing, is the most suitable one for balancing the weight of the moving parts as it makes the "arm" of the "rocking" couple as short as possible.

For the four-stage type the shortest arrangement of cylinders would be to have the high pressure and the low pressure forward, and the two intermediate aft. This will make the cranks of the high pressure and first intermediate at right angles, the first intermediate and second intermediate opposite; and of the second intermediate and low pressure at right angles. If it were desired to have the cranks of successive cylinders at right angles the arrangement could be high pressure cylinder forward, next the second intermediate, then the low pressure, the first intermediate pressure cylinder being aft. This would make the length over the cylinders rather more than with the previous arrangement, but would give greater facility than the other arrangement for making the weights of the two forward pistons equal and the weights of the two after pistons also equal.

As it is of importance that the initial loads be not increased by the pressure at release falling much below, or the initial pressure in the next cylinder rising much above, the mean back pressure, Figs. 10 and 11 have been prepared to show the variation in the exhaust line of the high pressure, first intermediate, second intermediate and also the variation in the admission pressure of the first intermediate, second intermediate and low pressure cylinders for cranks at right angles and cranks opposite. They also show the effect of different capacities of receiver space, the full lines representing the effect with receiver capacity equal to the cylinder, and the dotted lines the effect with receivers equal to twice the cylinder capacity.

The method of setting out is that described by Professor Unwin in "Elements of Machine Design," except that allowance has been made for the effect of the angularity of the connecting rods. It will be seen that, on the whole, the least increase of initial load is secured by the cranks at right angles, especially at the lower pressures. Hence the cranks of the second intermediate pressure and the low pressure should always be arranged at right angles; and if it is necessary to have any of the cranks opposite, they should be the high pressure and the first intermediate pressure, or the first intermediate pressure and the second intermediate pressure.

In conclusion, the writer would again emphasize the main point which he has attempted to bring out in the paper, viz., the importance of keeping down the cost of the new machinery. This means that a change to a cheaper type of boiler would be desirable, and that the design of the engines should be such as will give the minimum number of bearings and working parts.

REPORT UPON THE CONDITION OF ADMIRAL CERVERA'S VESSELS.*

AFTER AN EXAMINATION BY A BOARD OF UNITED STATES NAVAL OFFICERS.

Special Attention Given to the Effect of Our Gun Fire, of Combustible Material, and Explosions—Sketches Showing Number and Location of Hits—Conclusions Drawn by the Board.

TORPEDO-BOAT DESTROYERS PLUTON AND FUROR.

The Board visited the locality of the wrecked torpedo-boat destroyers Pluton and Furor on the morning of the 7th of July, 1898, and reports as follows:

Pluton—The Board finds that the torpedo-boat destroyer Pluton, after having been seriously damaged by the fire of our squadron, was wrecked upon the rocks about three miles west of the Morro, and that the wreck is now entirely submerged. The wreck lies slightly to the westward of Cabanas Cove. The only part remaining visible are some davits, which are awash in the surf.

The Pluton was on the rocks on the afternoon of the 3d inst., and on the morning of the 7th, when the Board passed her position, she was entirely submerged; the only thing visible about her being the davits awash in the surf, as above mentioned.

It is therefore impracticable to wreck the Pluton.

Furor—The Furor was sunk in deep water by the gun fire of our squadron. It is reported by the officers of the Gloucester that her structure, at the time she sank, was in fair condition.

The considerable depth of water, which is not accurately known, probably precludes the possibility of wrecking her.

Almirante Oquendo.

CONDITION OF HULL.

Condition of Flotation—The vessel lies uneasily, down by the stern, with slight heel to starboard, flooded throughout. The bow is about 3 feet light and the stern about 8 feet deep. The angle of heel aft is about 4 degrees, and forward about 7 degrees. No soundings were taken, for as seen below, the vessel is a structural wreck, and practically broken in two. Examination was limited to the above water portion.

STRUCTURAL SOLIDITY.

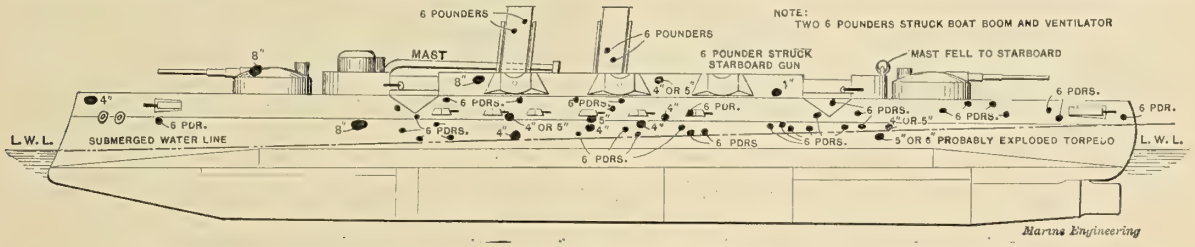
Frames—The magazine forward wrecked the frames on both sides above the protective deck. On the starboard side, the heels of frame were torn from the protective deck; the whole side being blown out for a distance of about 60 feet, extending aft from the transverse armor. The side in this region hangs about four feet beyond the outer edge of armor belt. On the port side the frames are blown away with the skin plating just above the protective deck for a distance of about 15 feet in length by 6 feet in width. Explosion on the after waist torpedoes carried away frames with the skin plating just above the protective deck for a distance of about 12 feet long by 4 feet wide.

Deck Beams—In wake of the forward magazine, explosion extending over a length of about 40 feet aft from the forward turret, the deck beams throughout are practically destroyed. The platform deck is seen upheaved to the protective deck on the port side. The protective deck beams are wrenched from their fastenings at the sides and are sheared along the seams of armor plate amidships and on port side; the deck opening up and being heaved up in the upper part to about the height of the gun deck. The gun deck beams and upper deck beams are

*Second and last installment of the complete report of the Board of Examination.

blown away, dislocated, and deformed in the region of the explosion. Over the torpedo explosion aft, the deck beams of the gun deck are similarly dislocated and deformed for a distance of about 15 feet. In addition to the above injuries by explosions, deck beams of the gun and main decks have been warped, dislocated, and in some cases dropped down from the effects of heat in a manner similar to that found on the other vessels.

Bulkheading—Below the protective deck is blown away in the region of the magazine explosion, as far aft as the boiler-room bulkhead. It is doubtless blown away, for some distance at least, on the forward side of magazine, where examination could not



ALMIRANTE OQUENDO—APPROXIMATE LOCATION OF HITS AND PROBABLE SIZE OF PROJECTILES.

extend. The bulkheading above the protective deck has been affected by heat in a manner similar to that on the other vessels previously described.

COVERINGS.

Outside Plating—The outside plating is broken vertically on both sides, from the height of the protective deck to within a short distance of top of bulwarks about abreast the forward turret just forward of the transverse armor, the cracks generally following a zigzag course along rivet lines. A similar crack starts on the port side at the armor shelf, about awash at this point, about 30 feet farther aft, and extending downward beyond the limit of visibility. On the starboard side, from the transverse armor to the boiler-room bulkhead, the plating with frames are wrenched from their fastenings at the upper edge of the armor, and hang about four feet beyond the side of armor belt. On the port side a plate is blown entirely off at a short distance above the protective deck, and the joint with the armor belt is broken off for about 40 feet; the side plating being about one foot and one-half inside of the armor belt. Aft, abreast the torpedo explosions, a plate is blown off on each side.

Deck Plating—In the region of the magazine explosion forward, the platform deck is completely wrecked; in parts it is blown up against the protective deck. The protective deck is also completely wrecked, being torn from the sides and opened up along the two armor seams; shearing the beams and being heaved up 5 to 10 feet. The gun deck and upper deck have been affected by heat more or less as in the other vessels previously described. Thus the vessel is practically broken asunder in the region of the forward turret, and, without taking into account other structural injuries, it is evident that it would be impossible to raise and save her. Moreover, in view of the uneasy condition of flotation, she is liable to break in two under even a moderate stress of sea and it therefore is advisable to begin the operation of stripping her at the earliest moment practicable.

EFFECT OF EXPLOSIONS.

Torpedo Explosions—Conditions—The region of the explosions is flooded and more than a partial examination was impracticable. Effects—Generally speaking, the injurious effect was limited to knocking off completely one plate of shell plating and dislocating or distorting three or four of the gun deck beams. As far as can be seen, the protective deck is uninjured. It is to be noted here, as on the torpedo explosion on the Vizcaya, that at a very moderate distance, not greater than three feet, the protective deck successfully withstood the shock.

Magazine Explosions—Conditions—The quantity of explosives, and the exact location of the explosions could not be determined. From the effects

OFFICIAL PHOTOGRAPH OF THE WRECK OF THE TORPEDO BOAT DESTROYER PLUTON.

produced, however, it would seem that the main forward magazine exploded; the location being practically the same as on the Vizcaya. Effects—The general effects are similar to those of the forward magazine explosion on the Vizcaya, though they indicate a more violent explosion. The structural weakness at the juncture of the forward and the midship portion of the vessel, arising from the discontinuity of the protective deck, is brought out more strongly; the explosion, combined probably with some effect of uneasy grounding causing the vessel to break in this region. It showed a weakness of juncture of upper works and protective deck, and protective deck with belt armor; a fact less markly shown in the case of the Vizcaya. Similar cutting away of bulkheads below the protective deck is seen, and in addition the platform deck is visibly upheaved toward the protective deck. Similar stiffening effect of structures above the protective deck is shown in the case of coal-bunkers, conning tower, turret, etc., giving the same wavy appearance.

CONDITION OF ORDNANCE EQUIPMENTS, ETC.

The after 11-inch gun and mount is in excellent condition. At the forward 11-inch gun a shell struck and exploded between the gun and the turret shield. This shell probably killed the men found dead in this turret. It jammed the turret, broke the plate forming the left side of the gun port in the shield, where it struck, cut the pipes and connections in the turret, and completely disabled it. The gun and the heavy parts of the mounts seems to be uninjured. Both 11-inch gun mounts require such work as will correct the injurious effect of the elements; and in the forward turret the piping needs renewal in order to make the turret serviceable.

The 5.5-inch (14 cm.) battery is burned, but not to such an extent but that it can be rendered serviceable by cleaning, overhauling and repairing. Several of the 5.5 (14 cm.) guns will need the new breech blocks. The after 5.5 (14 cm.) gun on the starboard is dismounted. It lies with its trunnions on the slides of the lower carriage, the cnase resting in the bottom of the gun port of the shield. Neither the gun nor carriage seems to be damaged, and it is quite possible that this gun was thus dismounted by the mainmast falling upon it. The mainmast now lies across the chase of the gun. New cap squares seem to be the only repair necessary for this gun.

The next gun forward, on the starboard side, has the mark of a 6-pounder shell in it just forward of the trunnions. The shell penetrated to the depth of 1½ to 2 inches. This will probably render the gun dangerous for service use.

The shield of the third gun on the port side has a 5-inch hole through it; minor portions of the mount are also damaged.

The secondary battery on the lower dack is very badly burned. While it can be saved, and possibly be made serviceable again, it is questionable whether it is desirable to do so.

The torpedo outfit is so badly damaged by shot and fire as to be ruined. At the port after broadside torpedo tube a violent explosion has occurred, probably that of one or more of the torpedoes located in that compartment. This explosion wrecked the torpedo compartment, the torpedo tubes, and the torpedoes stowed in the racks on both sides of the compartment.

The magazines are all under water and could not be examined; but the forward magazine has evidently exploded, forcing the protective deck up several feet, detaching it from its fastenings to the side, and blowing out both sides of the ship, especially on the starboard side. The after magazine, apparently, did not explode.

CONDITION OF MACHINERY AND BOILERS.

There is no evidence of the engines being damaged, nor any of the boilers having exploded. Water covers all the machinery, so that a close examination cannot be made. All pipings and auxiliaries above the protective deck are destroyed or damaged irreparably.

EFFECT OF GUN FIRE.

The effect of gun fire upon this ship was terrific. The sides, smokestacks, ventilators, hatch trunks, all seem to have been riddled by shell, by fragments of shell and by an infinite number of small projectiles. When it is considered that boats which no longer exist were in place and must have been frequently hit, it will be recognized that the effect of this fire was quite sufficient to create dismay among the ship's company besides setting fire to the woodwork.

It has been reported by one of the Oquendo's crew that a torpedo was struck by a projectile, which caused it to explode, killing a great number of men. This report is probably correct, as the effects of two such torpedo explosions are found on board the Oquendo, one at the after broadside tube on the port side and the other in the forward broadside torpedo room. A shell pierced the side of the after broadside torpedo room within a few feet of the torpedo tube, and may have exploded the torpedo head. The board could not substantiate the report by the evidence available. The forward torpedoes were doubtless exploded by the heat of the flames in that vicinity.

The intense flames to which the three ships were subjected, and the serious explosions of magazines and torpedo heads, caused by the heat of the flames, have so completely consumed all articles and material of inflammable nature that it has been impossible to describe more definitely and in detail the effect of the gun-fires.

Three 8-inch, one of them an armor-piercing shell, passed completely through the ship, striking in the superstructure and passing through the drum-rooms and bulkheads and out under starboard sea ladder at the water-line.

One 8-inch common shell struck the hood of the forward 11-inch gun, at the edge of the port, detaching one of the port lanyards, bursting, and evidently killing every one in the turret and disabling the gun.

The approximate location, direction and the size of the shell which struck the Oquendo are given in detail as follows:

Commencing forward on the port side:

One 4-inch shell went in on the gun-deck, ranged from aft forward near the moulding of the bow.

One 6-pounder entered just under the forward 6-pounder sponson, under the gun deck, and ranged from aft forward.

One 8-inch common shell struck the hood of the forward 11-inch gun at the edge of the port, bursting, and killing the gun's crew, as noted above.

An 8-inch shell also struck under the gun deck, directly below the conning tower, ranging forward and across the deck.

One 6-pounder entered the gun deck, under the forward part of the sponson for the forward 5.5-inch gun.

Another 6-pounder entered directly under the point of the sponson on the gun deck.

A third 6-pounder shell struck under the after edge of the same sponson. All ranged from aft forward.

On the berth deck, directly under the forward and after parts of the same sponson, are holes showing the entrance of four 6-pounder shells, each ranging forward and across the deck, so that, underneath this one sponson, there are seven 6-pounder holes and one 8-inch hole, showing the terrible effect and concentration of our gun fire at this point.

One 8-inch common shell passed through the superstructure and across the deck in front of the forward smokestack.

Near the top of the forward smokestack are also two 6-pounder holes, one ranging forward and the other ranging aft.

Directly under the forward smokestack, on the gun deck, are two holes, one from a 6-pounder, ranging forward; and just below it a 4-inch or 5-inch shell hole, also ranging forward.

One the berth deck, at the same point, is a hole from a 4-inch, ranging forward and across the deck.

About the middle of the after smokestack are two holes from 6-pounders, ranging forward.

Two 6-pounder shells also struck the boat boom on the mainmast, and the ventilator just forward.

Just under the after smokestack, on the gun deck, are the holes of five 6-pounders, all ranging forward and across the deck.

Also down on the berth deck, at the same point, two 4-inch shells entered, ranging forward and across the deck; and just beneath them two 6-pounders.

In the superstructure, just abaft and after smokestack, a 4- or 5-inch shell struck and ranged foward.

A 6-pounder shell passed across the deck at this same point, and struck the gun on the starboard side.

On the gun deck, under the sponson for the second gun from aft, are the holes of one 4-inch and two 6-pounders; and on the berth deck, just under the same point, are the holes of three 6-pounders, all ranging forward.

Just forward of the after sponson, in the superstructure, a 4-inch shell passed through from aft forward.

Under the after sponson three 6-pounder shells passed in the gun deck, from aft forward.

On the berth deck at the same point are six 6-pounder holes, all ranging forward.

Just beneath the forward part of the after barbette is the

hole of a 4-inch or 5-inch shell, ranging from aft forward and across the deck.

On the gun deck, between the after part of the after barbette and the sponson for the after 6-pounder gun, are the holes of five 6-pounder shells, ranging from aft forward and across the deck.

Just abaft the sponson for the 6-pounder on the gun deck is another 6-pounder hole, ranging forward.

As the vessel had settled so that the main deck was not more than six feet out of the water quite a large area of the hull could not be inspected. The armor belt was not struck or pierced as far as could be observed.

Three 6-pounder armor-piercing shell pierced the hull on the starboard side; the general direction of these was from aft.

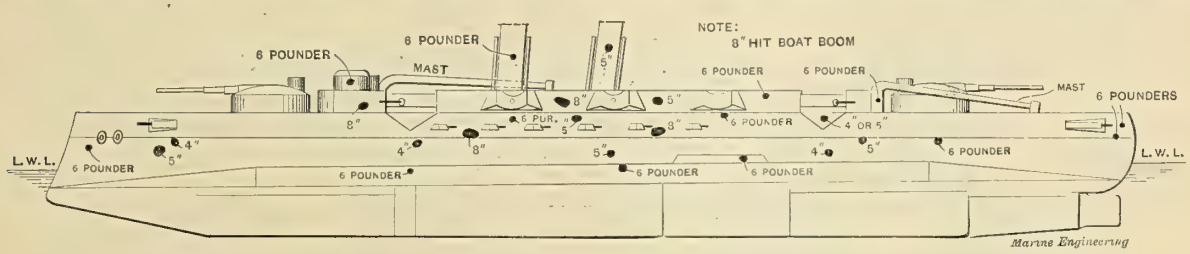
CONCLUSIONS.

The Oquendo was beached in a small cove about one-half of a mile to the westward of the Infanta Maria Teresa. It would be most difficult, if not impossible, to save this vessel. She is structurally wrecked, and is practically broken in two at a point about abreast the forward turret, besides being more or less severely injured elsewhere. The Board finds, for the above reason, that it is impracticable to wreck the Almirante Oquendo; and is further of the opinion that with the proper wrecking facilities, the battery of 5.5 (14 cm.) and the turret guns may be saved to advantage.

Vizcaya.

CONDITION OF HULL.

Condition of Flotation—The vessel is nearly upright, and lies in a position corresponding nearly to the L. W. L. Flooding of the hull is nearly complete fore and aft. The vessel rests easily, but as the structural solidity does not warrant the effort to save the vessel, as pointed out below, diving and complete soundings were not undertaken.



VIZCAYA—APPROXIMATE LOCATION OF HITS AND PROBABLE SIZE OF PROJECTILES.

STRUCTURAL SOLIDITY.

The examination extended inside that portion of the hull now above water, corresponding to the position above the protective deck, as well as to the portion immediately below the protective deck in the vicinity of the magazine explosion. Frame—Above water, the frames are cut forward on the starboard side for a distance of about 12 feet abreast the torpedo manipulating room, in wake of the torpedo explosions.

The frames are torn from their fastenings to the protective deck on the starboard side in wake of the forward magazine explosion, along a space extending from abreast the forward turret aft for a distance of about 40 feet.

Deck Beams—The deck beams of the berth and gun decks forward, in the vicinity of the torpedo manipulating rooms, are broken for a distance of about 20 feet. The beams of the protective deck are sheared along the armor seam on the starboard side in wake of the forward magazine explosion, for a distance of about 30 feet, along a space extending aft from the transverse armor abreast of turret. The beams of this deck are sheared on two sides, along the armor seams, above the after magazine explosion, the effects of which extend from the after transverse armor almost abreast the turret forward to the glacis over engines. The beams of the gun deck are practically destroyed by distortion and dislocation for a distance of about 30 feet, above each magazine explosion. Those of the upper deck are similarly injured, though over a less extent and in a less aggravated manner. The heat effects of warping and distortion and the sinking beneath local weights extend generally to the upper and gun decks, being more pronounced where there is no metal plating. For the decks below water, although examination could not be made, the effects on the beams are doubtless more pronounced than those above the protective deck.

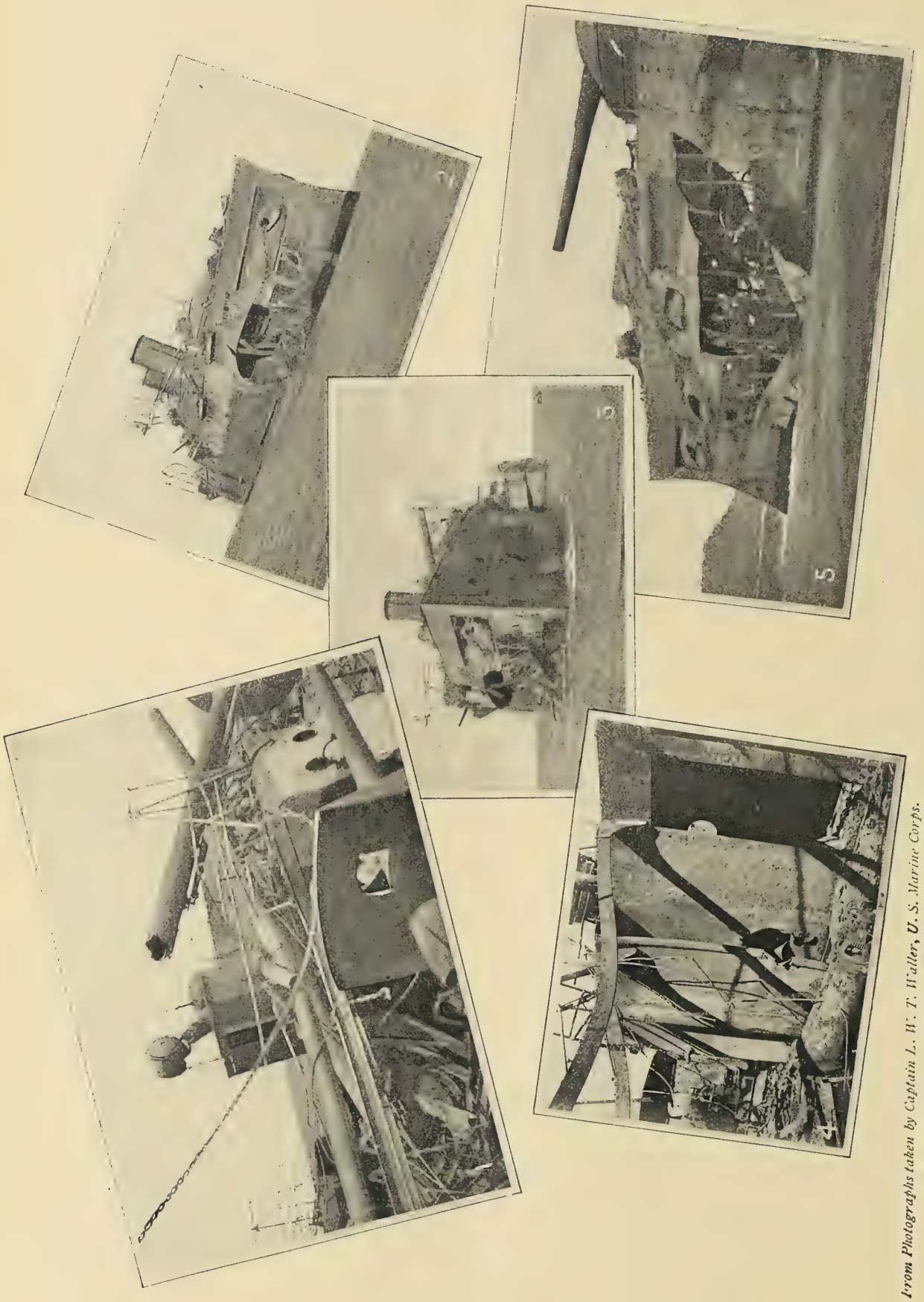
Bulkheads—Above water the bulkheading has been affected by heat in a manner more or less similar to that described for Infanta Marie Teresa. Below water, forward, the bulkheading is cut away from the transverse armor forward as far aft as could be seen; this injury extends to the boiler and engine spaces.

Coverings—Outside Plating—The outside plating is blown off forward on both sides in wake of the torpedo manipulating room for a longitudinal distance of about 20 feet. This injury extends from the protective deck at the sides in wake of the forward magazine explosion from the transverse armor aft for a distance of about 40 feet.

Deck Plating—The heat effect on stringers, tie plates and other plating of the gun deck and upper deck are more or less similar to these described for the Infanta Maria Teresa. Forward in the region of the torpedo explosion the plating of the berth and the gun deck is practically destroyed, being driven down in case of the berth deck. In the case of the gun deck, after being blown through, the deck fell down upon the berth deck, the deck beams and stanchions having been carried away. The gun deck carried also the weight of the windlass, which fell with the deck. Plating of the upper deck in the same region is blown through upward and folding back for a length of about 15 feet. Thus the explosion forward carried away the upper half of the longitudinal girder structure, and the longitudinal connections at the juncture of the transverse armor would, in all probability, break off. The magazine explosions carried away the larger part of the transverse stiffening members amidships, corresponding to the webb and upper flange of the transverse girders. This occurs in the part where the beam is the greatest, and the side weights heaviest. When parallel to the waves in a sea way, even if not in still water, the sides would settle and entail the vessel's destruction. Thus the internal explosions have destroyed the vessel's structural solidity, both as a longitudinal and transverse girder, and it would be inadvisable to attempt to raise the vessel.

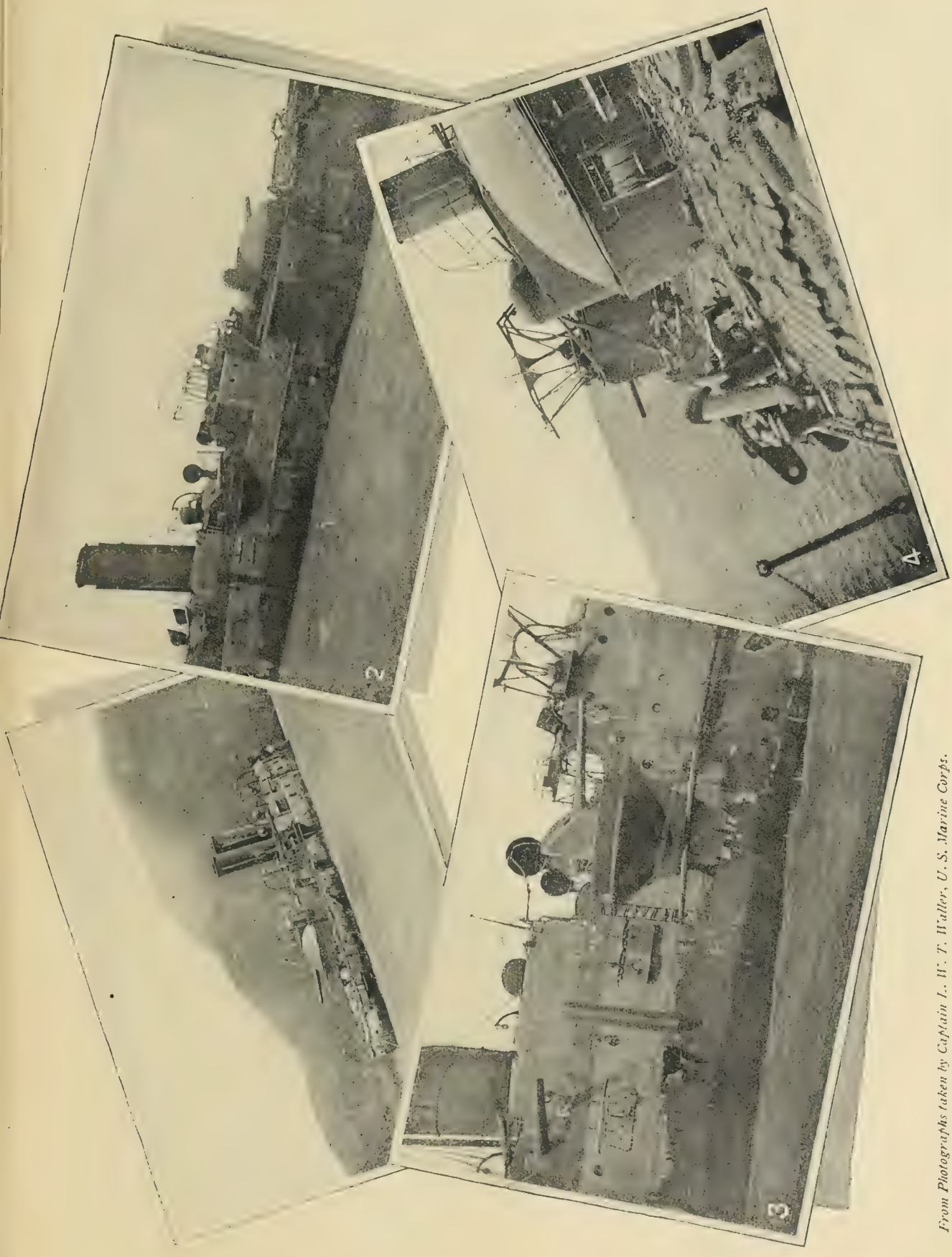
Internal Explosions—As seen above, this vessel furnishes examples of both forms of usual explosions.

Torpedo Explosions—The fragments of four torpedoes originally stowed in racks were found forward. The tubes remained lodged in their ports unbroken, the location of the explosion being about 10 feet abaft them. The size of the torpedo tube is fifteen inches. The torpedoes were stowed close



From Photographs taken by Captain L. W. T. Waller, U. S. Marine Corps.

U. S. OFFICIAL VIEWS OF THE WRECK OF THE VIZCAYA—REPRODUCED BY PERMISSION—FOR DESCRIPTIONS SEE PAGE 20.



From Photographs taken by Captain L. W. T. Walker, U. S. Marine Corps.

U. S. OFFICIAL VIEWS OF THE WRECK OF THE ALMIRANTE OQUENDO—REPRODUCED BY PERMISSION—FOR DESCRIPTIONS SEE PAGE 20.

to the sides, about about two and one-half feet above the berth deck. The cause of the explosion of the torpedoes was due to the heat of the flames in the vicinity.

Effects—As far as could be seen no damage whatever was done to the protective dock on either side. The berth deck was wrecked completely in the immediate vicinity, but over a comparatively small area; rather singularly a bulkhead below held a small part of the deck up in place, the downward thrust crushing, straddling, as it were, this bulkhead. The effect on the side plating on the gun and upper decks are given below. It is to be noted in this explosion of gun cotton that, though everything in the immediate vicinity was wrecked except a plate on end (the bulkhead below), yet at a moderate distance the armored protective deck gave effectual resistance, and beyond the gun deck the effect was more or less that of a lower order of explosion.

MAGAZINE EXPLOSIONS.

Conditions—Explosions occurred in both main magazines. The quantity of explosive and the exact location of the explosions could not be determined.

Effects—In both cases the protective deck in the region was blown open along an armor seam on each side; the plating in each case shearing the deck beams along the seam. The opening was greatest on the starboard side forward; there the armor plates were raised about five feet, making a wide breach through which the pressure relieved itself. The dislocation of the deck tore away the fastenings to the vertical armor, transverse and side, and tore away the heels of the frames above the protective deck, opening the ship's side along the joint of the protective deck. On the port side, forward, the upheaval and opening of the deck were small. After passing through the protective deck the effect of gases in all cases was small, as the pressure was practically relieved owing to the covering on the gun and spar deck having been burnt away. Below the protective deck the gases on the starboard side cut away bulkheads as far aft as the boiler-rooms, and seem to have partially cut bulkheads still farther aft. There was no execution on the sloping protective deck forward; the transverse armor having interposed an effective limit, but there is every reason to believe that below this deck the cutting away of bulkheads propagated itself forward as well as aft. The opening on the port side disclosed, beneath, a bulkhead folded *forward* by a rush of gas from aft.

In the explosion aft, the protective deck was raised amidships; shearing the beams on both sides at the seam of armor plates, well out toward the sides. The middle portion was raised about a foot along a distance extending from the transverse armor to the glacis over engine, the after glacis plate being dislocated.

Beneath the deck the same cutting away of bulkheads took place as was found forward. This extended as far forward as could be seen to about the forward bulkhead of the engine room. The openings in the deck have limited area and could give but partial relief to the gases which it would seem advanced forward and aft carrying down bulkheads as they went, till on the port side they reached the forward magazine. The protective deck by its strong resistance prevented the relief of pressure upward and in the progressive explosion the gases relieved themselves by propagation fore and aft below the deck, breaking down the less resisting bulkhead obstruction.

In the case of both magazine explosions the protective deck presents a more or less extended wave from being held down in place where weight and stiffeners existed as under conning tower, turrets, upper coal bunkers, etc., and being raised in proportions without upward stiffening.

CONDITION OF MACHINERY AND BOILERS.

The water covers the engines up to within 18 inches of the tops of the cylinders. So far as can be determined, the boilers and engines are intact, or, at least, not irreparably damaged.

The lagging is burnt off. There may be damage due to the fire having cracked castings; but this cannot now be ascertained.

Judging from appearances the fire was under way some time before the water rose in the engine compartment.

The same remarks concerning the boilers and piping above the protective deck can be made as in the case of the Infanta Maria Teresa.

EFFECT OF GUN FIRE.

The following was the effect of the gun fire of our squadron upon the Vizcaya, as noted by careful inspection:

Beginning aft, on the port side, there are:

Two holes made by 6-pounders passing through the sides into the berth deck, ranging from aft forward.

One 6-pounder shell made a clean hole through the ship's side into the berth deck, just abreast the after turret.

One 5-inch entered a little over and abaft the after broadside torpedo tube. It passed on to the berth deck, ranging forward, and carried the torpedo tube away from its fastenings.

One 4-inch shell entered the berth deck under the after edge of the after 14 cm. gun sponson, and ranged through to the other side.

One 6-pounder went through the superstructure just forward of the after 5.5 (14 cm.) gun.

One 6-pounder went in on gun deck under the second 5.5 inch (14 cm.) gun from aft, and did not explode.

One 8-inch shell struck on the gun deck just abaft the after smokestack, ranged aft and across the deck.

One 5-inch shell entered the berth deck abreast the after smokestack, ranging from aft across the deck.

One 8-inch shell went through the superstructure sideways, midway between No. 2 and No. 3 14 cm. gun. It ranged across the deck.

One 6-pounder entered the gun deck under No. 2 5.5 (14 cm.) gun.

One 8-inch shell entered on the gun deck between Nos. 1 and 2 5.5-inch gun and ranged forward across the deck.

One 4-inch entered on the berth deck just under the sponson for the forward 5.5-inch gun, ranged forward and across the deck.

One 6-pounder struck a slanting blow from forward aft on the upper edge of the armor belt about four inches from the top and abreast the after smokestack. It penetrated about an inch.

Another 6-pounder glanced off under the sponson of the forward 5.5-inch gun.

One 8-inch shell struck the superstructure just under the bridge, went through the men's head and then burst, scattering fragments about the decks. It ranged from aft forward. Some of the fragments struck the forward barbette.

One 5-inch and one 4-inch struck under the bill board of the port sheet anchor, passing in on the gun deck. One ranged forward, and the other across the deck.

One 6-pounder passed through the forward smokestack, one-third up from the deck.

One 5-inch passed through the after smokestack, near the top. Both shots were apparently fired from the quarter.

Descriptions of the Official Photographs of Spanish Warships Wrecked and Sunk at Santiago, in the Naval Engagement July 3, 1898, Reproduced on Pages 18 and 19.

VIZCAYA.

1. Showing destruction of main mast and shot holes in boat boom.
2. Showing effects of internal explosion of torpedo.
3. Bows on.
4. Showing where 8 in. shot passed through port head.
5. Port bow, showing rent caused by explosion.

ALMIRANTE OQUENDO.

1. View of ship from starboard quarter.
2. Broadside opposite starboard bow.
3. Starboard side, showing exit of large shell.
4. Shows sinking of turret after magazine explosion.

The derrick-boom of the mainmast is bent in two, about nine feet from the goose neck, by an 8-inch shell.

One 4-inch or 5-inch passed through the sponson of the after 5.5-inch (14 cm.), just under the gun.

One 6-pounder entered the superstructure from directly astern, and ranged forward.

One 4-inch and one 5-inch penetrated the deck from aft directly under the bill board.

One 6-pounder entered the gun deck forward of the hawse pipe, ranging forward.

The forward compartment of the ship was destroyed by an explosion of the torpedoes stowed there. The explosion was undoubtedly due to the heat of the fire at that place.

The sides are blown out, the supports are blown away, so that the capstan, anchor chains, bitts, etc., fell down to the deck below. The beams of the gun deck and the spar deck are carried away on the starboard side, and the spar deck plating of the starboard side is turned up into the air. The racks for holding the bow torpedoes were found in the forward compartment, and parts of the exploded torpedoes were also found.

It is evident that the fire of the guns' crews of the Vizcaya was very materially lessened and almost silenced by their not being able to serve their guns under the severe fire poured upon them by our ships.

The fact that no wood work is found remaining on board the Vizcaya—except that which is still smoldering about the scroll work of the bow—is evidence of the effect of the shell fire upon a ship in which any considerable amount of wood work is employed.

From observation, the fire seems to have started well aft in the ship, whence it spread very rapidly to the rest of the ship.

The after magazine blew up about 12.30, not long after this vessel was beached. The explosion destroyed the protective deck, and, in places, raised it considerably out of position.

The evidence of the effects of the explosion of *many* of our shells is lacking, although it is probable that pieces of exploded shell may have struck parts since consumed or destroyed by fire. There is evidence, however, that two large shell—8-inch—exploded. The effects of this explosion must have been very disastrous to men in that vicinity.

One 6-pounder and one 5-inch shell went through the ship from side to side.

As a precaution, in case the torpedo tubes should be struck, they were all fished with grate bars and chains in the wake of the war heads.

The number of shells that struck the ship seemed to show by their direction that about one-half struck as she was leaving the harbor, the shell ranging aft, and the other half as she was attempting to run away.

CONCLUSION.

The Vizcaya was grounded and now lies almost directly in the fairway of the channel leading to Accerederos about eight miles west of the Morro of Santiago de Cuba.

The Board considers that the vessel has no structural strength either in a longitudinal or transverse direction sufficient to warrant the endeavor to wreck her.

The girder weakness is due principally to the cutting away of the internal structure, although the shell plating is more or less intact.

This cutting away of the internal structure extends to practically all the transverse connections lying between the forward and after diagonal armor. The bulkheads and deck beams throughout this entire space have been practically destroyed by internal explosions.

The fastenings of the armor deck with the ship's side have been practically torn apart, and no longer exists. There is no plating on the upper deck, nor deck stringers that are of any consequence.

The Board is, therefore, of the opinion that it is inadvisable to attempt to save the Vizcaya.

The Board recommends that the ship should be secured at once with anchors and cables, so as not to be moved from her present position until she has been stripped.

Secretary of the Navy John D. Long has written an important letter, under date of October 14, in response to an inquiry made by volunteer officers of the Navy as to the probability of their being permitted to remain permanently in the service. His reply is in the main unfavorable, and he evidently looks for a solution of the difficulty of having an insufficient number of officers in the Navy, in the passage of the Personnel Bill.

DEPARTMENT PLANS FOR TORPEDO BOATS AND DESTROYERS FOR THE U. S. NAVY, RECENTLY CONTRACTED FOR.

Bids were opened at noon on August 23, 1898, for the construction of twelve torpedo-boats and sixteen torpedo-boat destroyers, the total cost of all, exclusive of armament, being limited by the appropriation bill to $6,900,000, and with a proviso that not more than four torpedo-boats, nor more than five destroyers, should be built in any one yard, or by any one contracting party.

The Department invited bids under two classes, viz.: The first, for the construction of hull, machinery, and their appurtenances complete in accordance with the plans and specifications provided by the Secretary of the Navy, and the installation of ordnance and outfit; the second, for the construction of hull, machinery and appurtenances complete on plans and specifications submitted by the bidder, and the installation of ordnance and outfit in accordance with the requirements of the Department.

In the circular calling for bids, certain essential elements of design were stipulated in order to place intending bidders, under class 2, on the same footing, and also to obtain vessels having similar characteristics as nearly as practicable. For the torpedo-boats these were:

1. Displacement between 150 and 170 tons.
2. Vertical propelling engines in separate water-tight compartments, each with a condenser, driving twin screws.
3. Water tubular boilers, and a coal bunker capacity of at least 40 tons.
4. Berthing space for a crew of 26 men and 3 officers, and provision space for 20 days.
5. Guaranteed speed of at least 26 knots.
6. On an official trial of two hours, vessels to average the guaranteed speed with every part of hull and machinery complete, including spare parts and fresh water necessary; and in addition, to carry ordnance weighing 9 tons; coal, 10 tons; crew, stores and equipment of 8 tons.

Free scope was allowed in working out the design provided the above requirements were met, and the average cost of each vessel did not exceed $170,000. All bids had to be accompanied by complete plans and specifications for building, and such calculations of weights, displacement and stability as would demonstrate the strength and seaworthiness of the vessels. In considering bids so submitted, the Department obligated itself to give due preference to those designs, all other things being equal, which indicated the best sea-going qualities; gave the best protection to engines and boilers; guaranteed the highest speed; best suited, in general characteristics, to the naval service; and, finally, the shortest time in which bidders would guarantee completion.

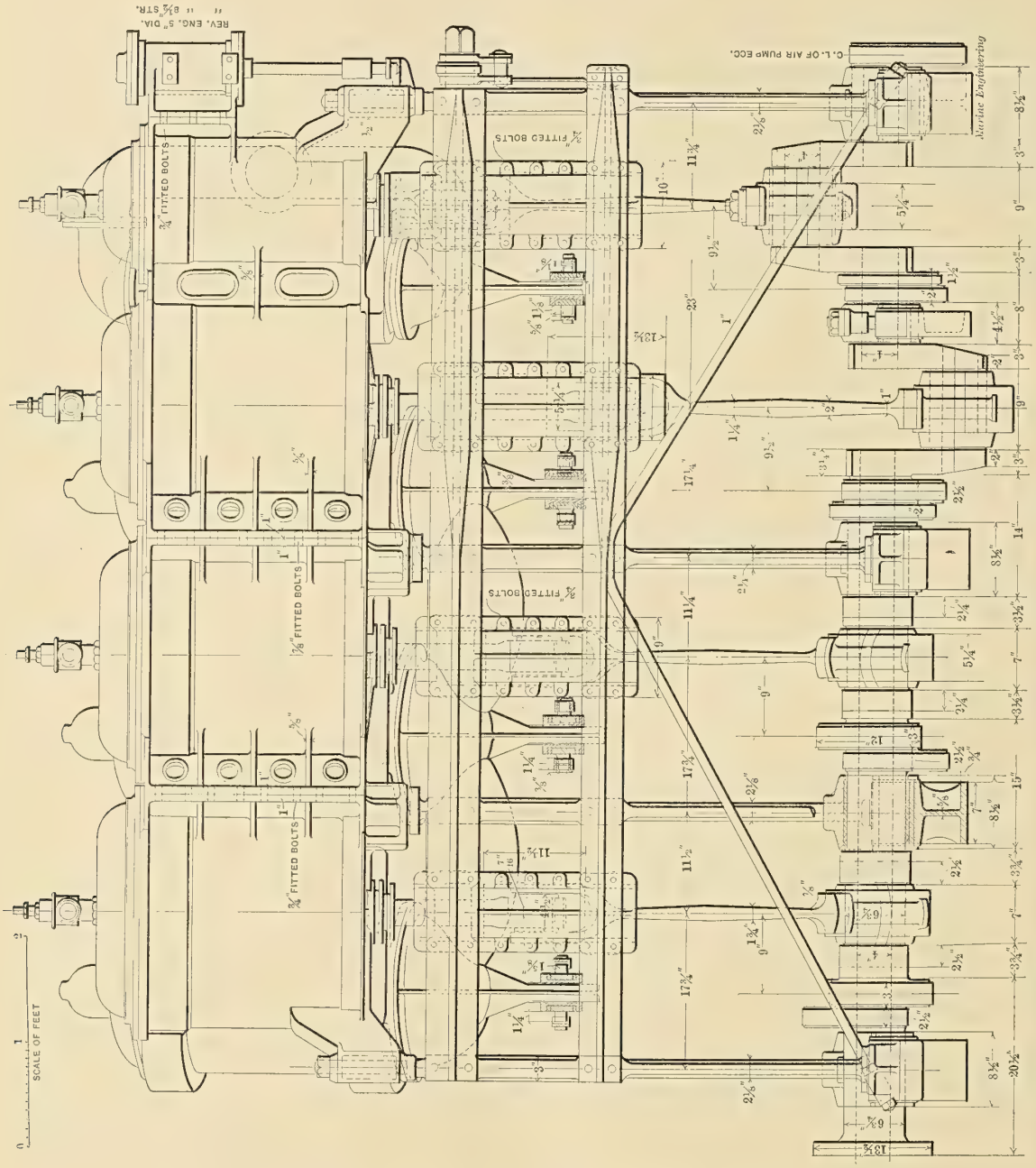
While the Government reserved the right to reject any and all bids not considered advantageous, no bid was to be considered which proposed a speed of less than 26 knots. On the trial, however, if the average for the two hours

fell below the figure guaranteed by the contractor, the vessel might be accepted at a reduction at the rate of $3,000 for each quarter of a knot, with the provision that a speed below 25 knots would subject the vessel to rejection.

The maximum time for completion under any circumstances was limited to twelve months, with penalty for over time as follows: $30 per day for the first month succeeding the period fixed; $60 a day for the next month, and $100 per day thereafter.

In plans of the destroyers, submitted by bidders, the average cost was limited to $295,000, due preference being given for desirable characteristics, as mentioned for the torpedo-boats, with restricting elements of design as follows:

1. Displacement between 400 and 435 tons.
2. Vertical propelling engines in separate water-tight compartments, each with a condenser, driving twin screws.
3. Water tubular boilers, and a coal bunker capacity of at least 100 tons.
4. Berthing space for a crew of 60 men and 4 officers, and provision space for 20 days.
5. Guaranteed speed of at least 28 knots.
6. On an official trial, of two hours, vessels to average the guaranteed speed with every part of hull and machinery complete, including spare parts and necessary fresh water; and in addition, to carry ordnance weighing 15 tons; coal, 25 tons; crew, stores and equipment of 12 tons.



REAR ELEVATION OF FOUR-CYLINDER TRIPLE-EXPANSION ENGINE FOR U. S. TORPEDO BOATS—BUREAU OF STEAM ENGINEERING DESIGNS—STARBOARD ENGINE.

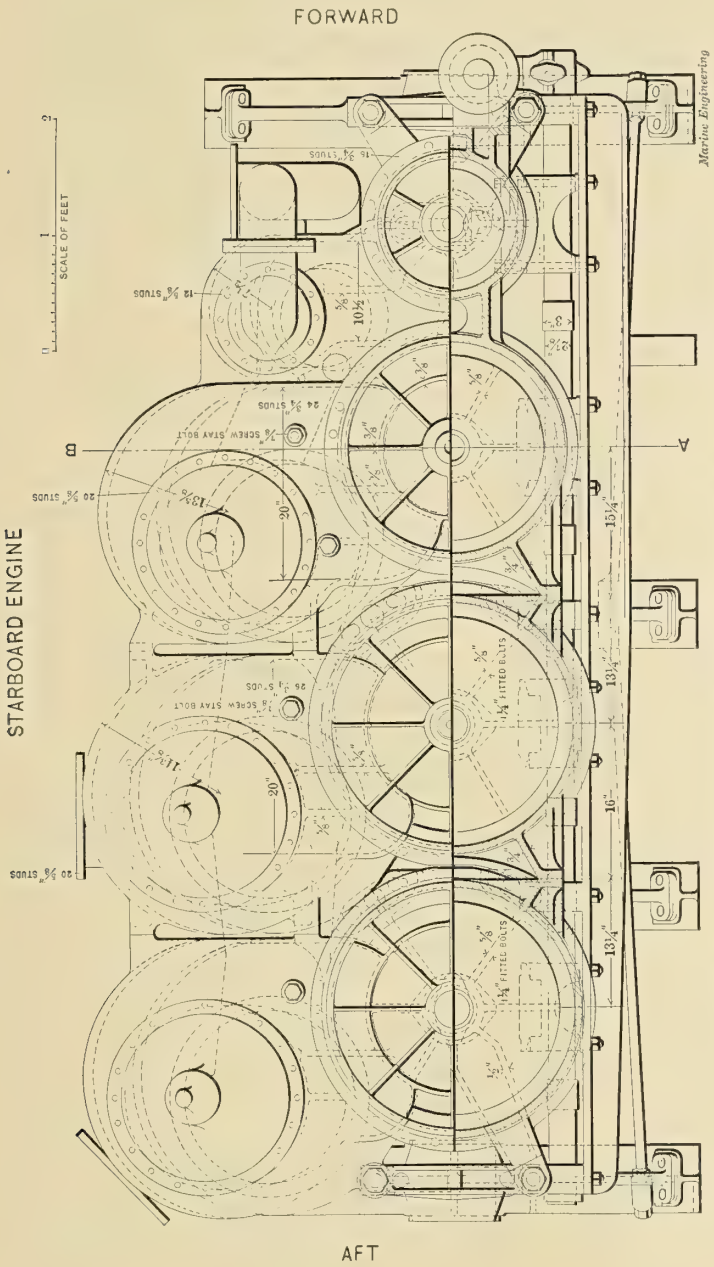
The maximum time allowed for completion was given as eighteen months, with a penalty, after specified time, of $50 per day for the first month; $100 per day for the second month, and $150 thereafter until delivery.

If on the official trial the average speed fell below 28 knots, the vessel was to be rejected; and for every 1-4 knot below the speed guaranteed by the contractor, a reduction of $8,000 was to be made. No premium was offered for excess of speed over that guaranteed. A summary of the essential features of the Department's design of both classes of vessels is given in the following:

TORPEDO-BOATS.

The torpedo-boats—designated from No. 24 (Bagley) to No. 35 (Wilkes)—are of about 7-feet draft, and have the following principal dimensions:

Length on load water line.....175 feet.
Breadth " " " .....17 feet.
Displacement (normal draft) about....165 tons.



PLAN OF TRIPLE-EXPANSION ENGINE FOR U. S. TORPEDO BOATS.

The outside plating is lap-jointed, and generally of 7 lbs. per sq. ft. (7-41 in. thick) for one-half of the length, being reduced to 6 and 5 lbs. respectively towards the stern and bow. Plates of the flat keel are of 10 lbs. for a length of 100 ft. amidships, reduced to 7 1-2 lbs. forward and aft. The vertical keel consists of 15-lb. plates of an average depth of 8 in.

Transverse frames and deck beams are bulb angle bars spaced 18 in., from center to center, throughout the length of the vessel, except in the engine spaces, where frames are disposed to accommodate the main bearings of the engines. For about two-thirds of the length amidships the frames and beams are 2 1-2 by 1 1-2 by 2 2-3 lbs. per lineal ft., reduced at the bow and stern to 2 1-8 by 1 5-16 by 2.2 lbs.

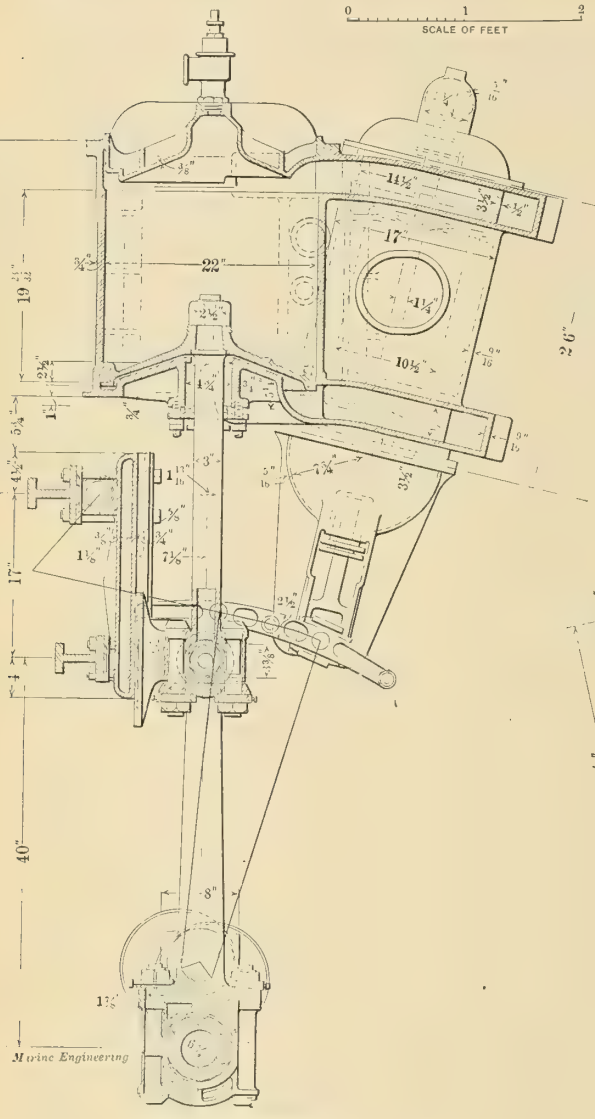
The floors are generally 12 in. at the widest part, lightened by holes where practicable, and extending continuously across the vessel from bilge to bilge, with reverse bars 1 1-4 by 1 1-4 by 1 1-4 lb. per ft. worked on their upper edges. Plates for this purpose are 10 lb. under the engines, boilers and thrust seatings; and elsewhere, throughout engine and boiler spaces, 8 lbs., reduced to 6 lbs. at the ends of the vessel.

Deck plates are generally of 4 lbs. per sq. ft., with a stringer of 6-lb. plate worked on the ends of the beams at either side.

The outside plating, frames, floors, etc., under water, and to 1 ft. above the normal water line, are galvanized by the hot process.

The engines are of the triple-expansion, vertical, direct-acting type, placed in separate water-tight compartments, driving twin screws, the designed horse power being 3,000 for both engines when making about 350 revolutions per minute. Their design is clearly shown in the accompanying scale drawings. Each engine has a high-pressure cylinder of 14 in. dia., one intermediate cylinder 22 in. dia., and two low-pres-

sure cylinders of 25 1-4 in. dia., all having a common stroke of 18 in.

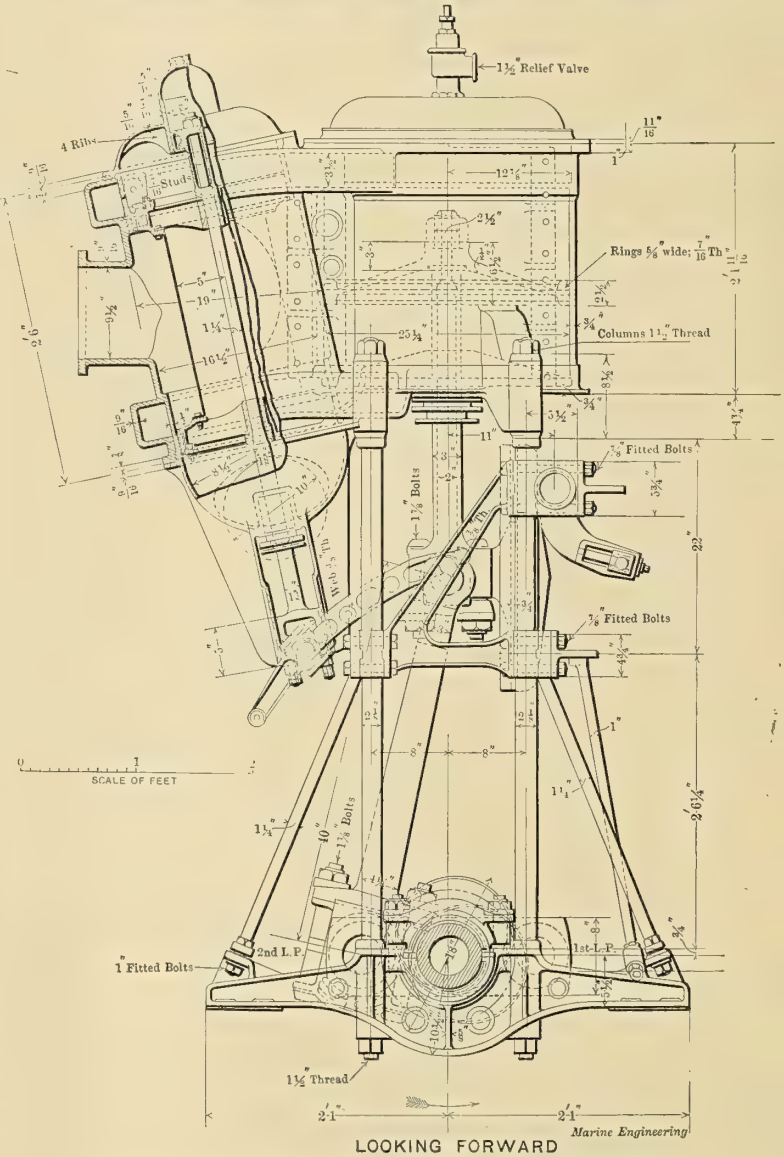


SECTION A-B—SEE PLAN

U. S. TORPEDO BOAT ENGINE.

To economize space in a fore and aft direction, the valves, which are all of the piston type—one for each cylinder—are placed on the sides and inclined to the cylinders. This arrangement is novel and admits of the use of eccentrics and Stephenson link motion for working the valves. The diameters of the latter are, respectively, 7 1-2 in., 14 1-2 in., 16 1-2 in., and only the two low-pressure valves are provided with packing rings, those for the intermediate and high pressure being turned and polished with emery to fit the valve liners accurately. It will be observed from the drawings that the center lines of all valve chests are parallel, but at varying distances from the fore and aft center line of the cylinders. Two main condensers, one for each engine, are installed. These are made entirely of composition and sheet brass, and each has a cooling surface, measured on the outside of the tubes, of 1,240 sq. ft. Air pumps are double-acting, one for each condenser, and driven from the main engine shafts. The circulating pumps are of the usual centrifugal type.

All shafting, piston, connecting, valve and eccentric rods, and working parts generally, are of the highest grade forged nickel steel oil-tempered and annealed. A test specimen, cut from each part, must show a tensile strength of not less than 95,000 lbs. per sq. in., an elastic limit of at least 65,000 lbs., with an elongation in 2 in., not falling below 21 per cent. In addition, a bending specimen must stand cold bending double to an inner diameter of 1 in. without showing cracks or flaws.



LOOKING FORWARD

TRIPLE-EXPANSION ENGINE U. S. TORPEDO BOATS.

Steam is to be furnished by by three coil, or tubulous boilers, each with separate smoke-pipe, and having at least a total grate and heating surface of 137 and 7,544 sq. ft. respectively. The boilers, as laid down in the Department's design, are of the Thornycroft pattern, but the successful bidder is free to adopt any other type, subject to the approval of the Bureau of Steam Engineering. Certain essential requirements, however, in any design submitted must be complied with as follows:

1. Boilers to be built for a working pressure of 250 lbs., and of sufficient capacity to supply steam, under forced draft, for all machinery at full power.
2. Tubes forming heating surface to be seamless cold-drawn steel.
3. All steam and water drums to have longitudinal seams welded, and where possible, circumferential seams to be welded also.
4. Efficient means to be provided for getting at the interior of such parts of the boiler as require attention for examination, cleaning, or repair.

In addition to the main machinery as described, the following auxiliaries are to be installed, viz.:

Two main feed pumps of 147 gallons capacity per mt., one aux. feed pump of 147 gallons capacity per mt., one fire and bilge pump of the same capacity, also three blowers and engines, and two evaporators and one distiller.

The weight of all the above machinery, including auxiliaries and water in boilers, condensers and pipes, and such stores and spare parts as may be carried on board when fully equipped, is not to exceed 79.7 tons.

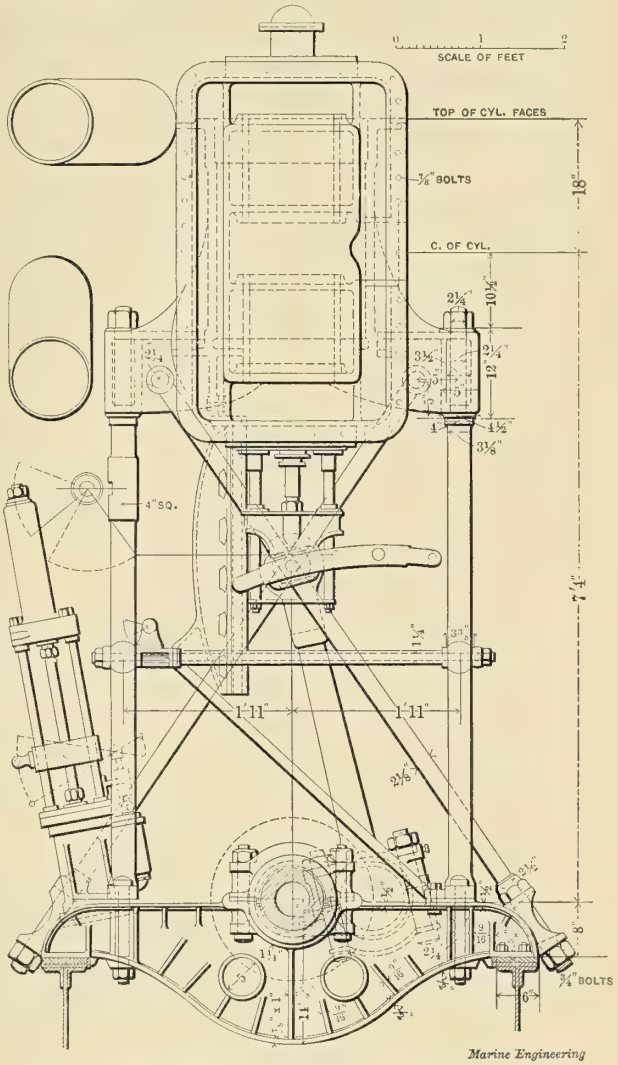
The battery of each torpedo-boat consists of three 3-pounder rapid-fire guns. Each vessel is also provided with three torpedo tubes and an outfit of five short Whitehead torpedoes, 3.55 metres in length. Two of the torpedo tubes are placed amidships, one on either side, and the third arranged for astern discharge. All ordnance weights, when completely supplied, amount to 12.7 tons and include the battery, ammunition, small arms, torpedoes, spare war heads, tubes, air compressor and its accumulator and piping, handling and transporting appliances, spare parts and accessories.

TORPEDO-BOAT DESTROYERS.

As shown in the Department's plans, the torpedo-boat destroyers have a draught of about 8 ft., with principal dimensions as follows:

Length on normal load water line	245 feet.
Beam " " " "	23 feet.
Displacement on trial about	420 tons.

The mild steel outside plating is generally of 9 lbs. per sq. ft., lapped seams and double riveted, for two-thirds the length amidships, reduced to 7 lbs. and single riveted at either end, with a nickel steel sheer strake of 12 1-2-lb. plate, reduced to 10 lbs. forward and aft; garboard strakes are of 10 lbs. amidships, reduced to 8 lbs. at ends, and flat keel of 12 1-2 lbs. for two-thirds the amidships length, reduced to 10 lbs. at bow and stern. The vertical keel is of 10-lb. plate.



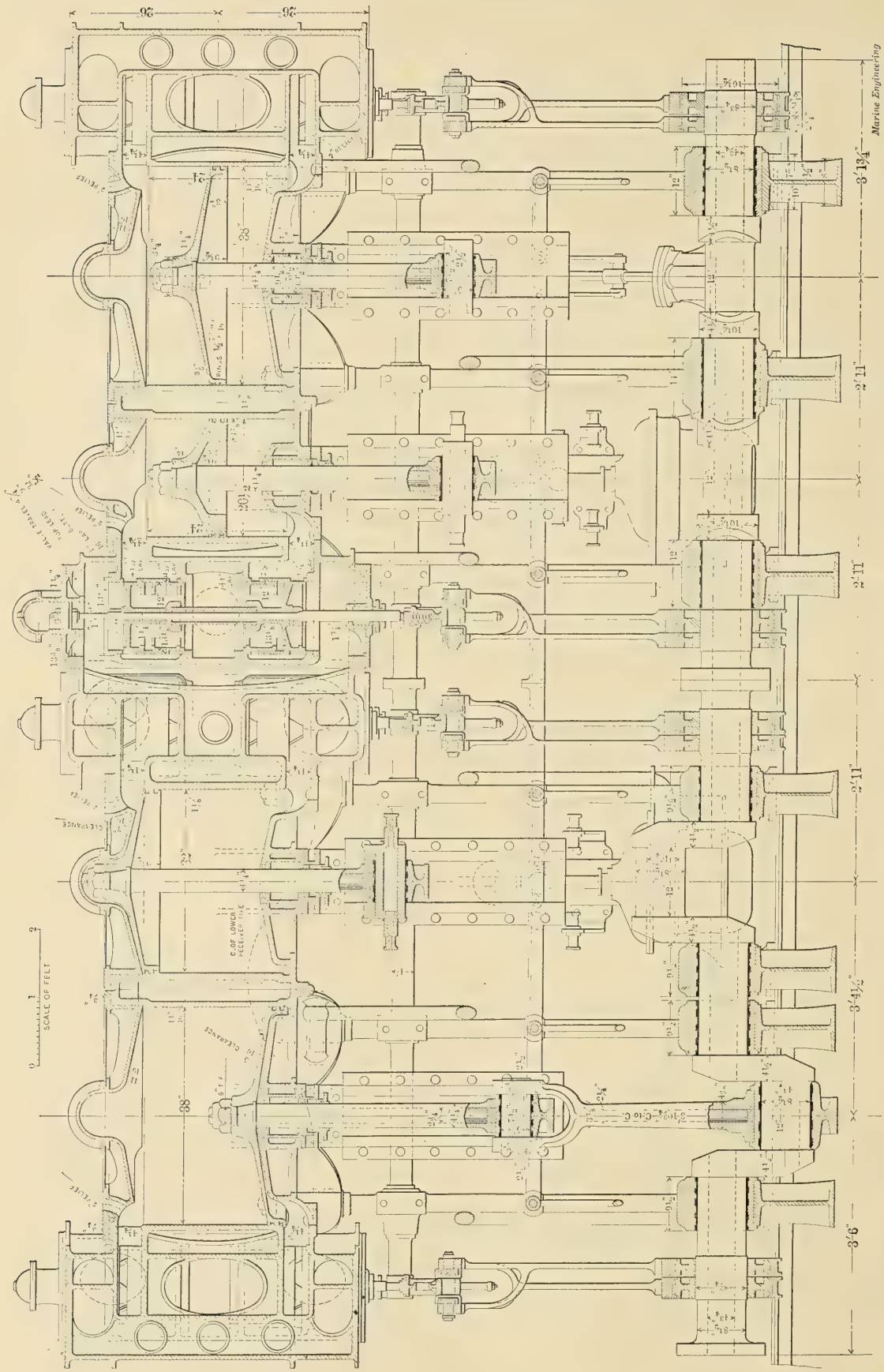
HIGH PRES. CYL. LOOKING FORWARD

TRIPLE-EXPANSION ENGINE U. S. DESTROYERS.

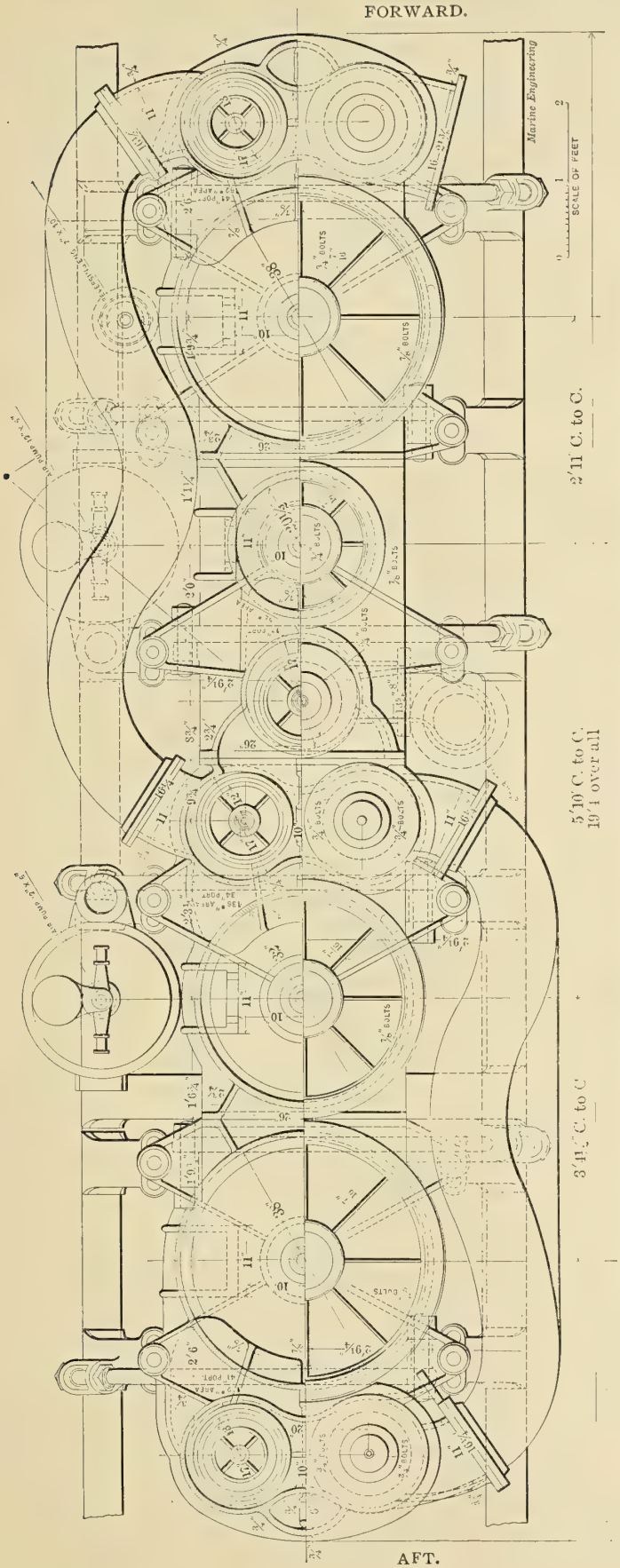
Transverse frames are spaced 21 in. from center to center, except in the engine compartments, where additional frames are worked or the spacing changed to suit the requirements of the engine beds. Bulb angle bars, in one length from deck to keel, form the frames. These are 2 1-2 by 1 1-2 by 3 lbs. per ft. in engine and boiler spaces, reduced to 2 1-2 by 1 1-2 by 2.2 lbs. elsewhere.

Floor plates of various depths, depending on location, are attached to every frame. These are of 8-lb. plates in machinery space, reduced to 5 lbs. at ends, with reverse bars, varying from 2 by 1 3-8 by 1 1-2 lbs. to 1 1-4 by 1 1-4 by 1 1-4 lbs., and extending from side to side.

Fore and aft coal-bunker bulkheads are formed of horizontal strakes, as long and wide as practicable, with edges and butts lapped, the former single, and latter double riveted. The lower



SECTIONAL ELEVATION FOUR-CYLINDER TRIPLE-EXPANSION ENGINES FOR U. S. TORPEDO BOAT DESTROYERS—BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT, PLANS.—PORT ENGINE.



PLAN OF FOUR-CYLINDER TRIPLE-EXPANSION ENGINES FOR U. S. TORPEDO BOAT DESTROYERS.

strake is of 7-lb. plate; the upper 12 1-2-lb. nickel steel, 18 in. in width, with plating between of 5 lbs. Vertical stiffeners are disposed on the inside, one to each frame, 2 1-2 by 1 1-2 by 2.2 lbs., and also a longitudinal, at mid-height on the outside, of the same dimensions.

Deck beams, one to each frame, have a crown of 10 in. in 23 ft., except beams for berth deck, which are without crown. The main deck beams are bulb angles 2 1-2 by 1 1-2 by 2 2-3 lbs. when not cut for hatches. Beams which are cut, and beams for forecastle and berth decks are 2 1-2 by 1 1-2 by 2.3 lbs.

The main deck plating is 7 lbs. to the sq. ft., with a 12 1-2-lb. stringer of nickel steel worked on each side over the ends of beams, and extending from forward to the after boiler-room bulkhead, after which a reduction to 8-lb. mild steel plate is made. Berth and forecastle decks have stringers of 7-lb. plate, with plating between of 5 lbs.

Bilge keels, made of I-beams, 8 by 4 1-4 by 18 lbs. per ft., with the lower flange removed, are fitted. These extend well beyond the limits of boiler and engine spaces, in a fore and aft direction, and so placed as to meet the least resistance in passing through the water.

The floor and bulkhead plates, reverse frames, frames and outside plating, to 1 ft. above the normal water line, vertical keel plates and bilge keels are to be galvanized by the hot process.

The propelling engines (shown in the scale drawings here published), which drive twin screws, are alike, placed in separate water-tight compartments, of the four-cylinder triple-expansion type, and designated for 8,000 horse power when running at 327 revolutions per mt., the steam pressure at the engines being 250 lbs. per sq. in. above the atmosphere. Each engine has a high-pressure cylinder of 20 1-2 in. dia., an intermediate pressure cylinder of 32 in. and two low-pressure cylinders of 38 in.; the stroke of all pistons being 22 in.

The order of cylinders, beginning forward, is, for the starboard engine, second low pressure, intermediate, high, and first low pressure; for the port engine, first low pressure, high, intermediate and second low pressure. Cranks are at 90 deg.,

the high and first low pressure being opposite, as are the intermediate and second low, the first pair being at right angles with the second. The object of this arrangement is to secure balance, and with this end in view the different pistons are so proportioned as to make the weights of the reciprocating parts the same for all cylinders.

All main valves are of the piston type, worked by double bar links, one for the high pressure, two for the intermediate and two for each low pressure. Each valve is made of two turned and polished heads, or pistons, without packing rings, the distance between the two being such as to produce the steam and exhaust lap required.

The engine framing consists of twelve forged steel columns, 3 1-8 in. dia., stiffened by horizontal tie-bars and stayed by diagonal braces, 2 1-8 in. dia. Bedplates are separate steel castings of I-section for each bearing, with webs of 1-2 in. thickness, supported upon and bolted to two fore-and-aft plates, which latter, worked into the framing of the vessel, form part of the engine keelsons. Only bottom crank shaft brasses, lined with white metal, are used, the bronze caps (also lined with white metal) taking the place of top brasses.

There is a condenser for each engine having a cooling surface, measured on the outside of the tubes, of 3,470 sq. ft. The shells are of sheet brass, No. 10 B. W. G. thick, made of sheets as large as procurable brazed together, with two stiffening rings of T-section for each condenser shell. Tube sheets are 3-4 in. Muntz metal, with 2,292 holes in each for the tubes, which latter are 5-8 in. outside dia., No. 20 B. W. G. thick, spaced 15-16 in. between centers, and 9 ft. 3 in. in length between tube sheets.

The air pumps, two for each engine, are vertical, double-acting, worked from the high and intermediate crossheads, and have water cylinders 12 in. dia., with a stroke of 6-in. For each condenser there is one water-balanced, centrifugal circulating pump, having a pump runner 20 in. dia., capable of discharging 2,000 gallons of water per mt. when connected to the bilge, and driven by a vertical single-cylinder engine of 4 1-2 in. dia. and 5-in. stroke.

The crank shaft of each engine is forged solid, in two sections, one 8 ft. 11 in., the other 9 ft. 10 in. long, with two cranks on each section placed opposite. Each shaft has seven journals, of which four are 9 1-2 in., two 12-in. and one 14 in. long. The shafts and crank pins are 8 1-2 in. dia., with an axial hole of 4 3-4 in., and are to be made of nickel steel of at least 80,000 lbs. tensile strength, not less than 50,000 lbs. elastic limit, and a minimum elongation, in 2 in., of 25 per cent.

Thrust, line and propeller shafts are 7 7-8 in. dia., with a 4 3-4 in. axial hole. These, as well as the working parts of the engines, are of nickel steel, with physical requirements the same as stated for similar parts in the torpedo-boats.

There are to be four boilers of the tubulous type, built to carry 300 lbs. steam pressure, each with separate smoke-pipe, the latter being oval in shape, and 18 ft. above the deck. The total grate and heating surfaces, of all boilers, is to be at least 315 and 17,768 sq. ft. respectively, and with these limitations, and subject to the requirements in other respects mentioned for the torpedo-boat boilers, the contractor is free to adopt any make. Two of the boilers are forward, the remaining two abaft the engines, and arranged in two water-tight compartments, with one fireroom for each pair of boilers.

The following auxiliary machine is to be fitted, in addition to that already mentioned: Four vertical, single-cylinder, main feed pumps, each with a steam cylinder of 10 in., 6-in. water cylinder and 12-in. stroke, and located one in each fire and engine room; one auxiliary feed pump, of the same size, placed in each fire room; one vertical, single-cylinder, fire and bilge pump, with steam cylinder of 6 in., water cylinder of 8 in. and stroke of 12 in., placed in each of the engine rooms; two blowers with necessary engines in each fireroom, and of sufficient size to maintain the maximum rate of combustion with ease under forced draft when discharging into closed firerooms; two feed heaters, one in each engine room, containing about 175 sq. ft. of tube heating surface in each; one hydraulic ash ejector in each fireroom; a fresh-water plant, consisting of two evaporators and one distiller, with a maximum capacity of 1,500 gallons of water for each of the former, and 200 gallons of potable water in 24 hours for the latter; there is also a small combined evaporator feed and brine pump, and a distiller circulating pump of rated capacity of 30 gallons per mt. installed in connection with the plant.

All machinery, including auxiliaries, water in boilers, condensers, pipes and feed tanks, stores and spare parts, when the vessel is fully completed and ready for service, is not to exceed 190 tons.

Each destroyer is fitted with two torpedo tubes and four long 5-metre Whitehead torpedoes, with a battery composed of two 12-pounder and five 6-pounder rapid-fire guns. The total ordnance weights, when fully equipped, and which includes similar details mentioned for the torpedo-boats, is to be 23 1-2 tons.

Following are the lists of the contracts let:

TORPEDO BOATS.

Name of Bidder	Location of plant	No. of vessels	Design	Price of each vessel
Trigg & Co.	Richmond, Va.	3	Depts.	$129,750
Gas Eng. & Power Co.	Morris H'g'ts, N.Y.	1	Depts.	146,000
Lawley & Sons	Boston, Mass.	2	Depts.	159,400
Bath Iron Works	Bath, Me.	3	Bidders	161,000
Lewis Nixon	Elizabethport, N.J.	2	Bidders	165,000
Columbian Iron Works	Baltimore, Md.	1	Depts.	168,000

TORPEDO BOAT DESTROYERS.

Name of Bidder.	Location of plant	No. of vessels	Design	Price of each vessel
Trigg & Co.	Richmond, Va.	2	Depts.	$260,000
Fore River Engine Co.	Weymouth, Mass.	2	Bidders	281,000
Gas Eng. & Power Co.	Morris H'g'ts, N.Y	1	Depts.	282,000
Neafie & Levy	Philadelphia, Pa.	3	Depts.	283,000
Union Iron Works	San Francisco, Cal.	3	Depts.	285,000
Maryland Steel Co.	Baltimore, Md.	3	Bidders	286,000
Harlan&Hollingsworth	Wilmington, Del.	2	Bidders	291,000

The above tables are corrected to date, and show the successful bidders, the number of vessels allotted to each, the design under which they are to be built and the contract price.

Experience with Outboard and Inboard Turning Propellers on S.Y. Niagara.

The following valuable information has been contributed by T. Jackson Shaw, Superintending Engineer of the Harlan and Hollingsworth Co., in a letter to the Editor of the Journal of the American Society of Naval Engineers.

I would like to give what may be interesting data on three trials of the twin-screw steam yacht Niagara,* built by the Harlan and Hollingsworth Co., for Howard Gould.

The dimensions of the yacht are as follows: Length between perpendiculars, 247 ft. 6 in.; beam, 36 ft.; depth to the spar deck, 28 ft. 2 in.

On trial our draught of water was 17 ft. aft and 15 ft. 9 in. forward. The total displacement was 2,240 net tons. This weight included 400 gross tons of coal, 15,000 gallons of water in tanks, and all stores and outfit on board. The yacht is designed with the Lundborg shaft carriers instead of struts.

After careful consideration as to the direction to run the engines—as to turning the wheels inboard at the top or outboard, and making inquiry from different sources on this subject—also having learned that the British Admiralty were building battleships on the other side with tops of the wheels turning inboard, I concluded to follow out the same on the Niagara.

The engines are of the triple-expansion type, having three cylinders, 18 in., 28 in., 45 in. by 30 in. stroke. Boilers three in number, Scotch type, having a total of 204 sq. ft. of grate, and built for a working pressure of 160 pounds per square inch.

We burned on the trials good quality of hard coal with natural draft, she having no appliances for forced draft.

The first wheels were 10 ft. in diameter, 13 ft. pitch, having a Griffith-shape blade.

The result of the first trial was as follows:

The average revolutions of the engines, 128; average steam pressure, 156; average speed, 12.54 knots; the course being from Scotland Light Ship to Barnegat. The slip of the wheels, you will see, was 23.6 per cent.

After thinking over the matter, I concluded in my own mind that the Lundborg extensions prevented the water from getting to the wheel properly, and I decided to increase the diameter of the wheels 6 in., increase the blade area on the points, and increase also the pitch to 14 feet. This was done, the ship docked, and the new blades put on, but no change was made as to turning the engines in the opposite direction. With this change in the wheels, over the same course, the ship on the same draught, we made an average speed of 12.8 knots on an average revolution of 126, showing the slip to be in this case 26.4 per cent.

After this trial I immediately decided to run the wheels in the opposite direction, the guides of the engines being of such design that this could be done very readily. I therefore docked the ship, put the starboard wheel on the port engine and the port wheel on the starboard engine, with the result on trial on August 16, the ship being still in the same condition of draught, etc., as follows:

Our average speed was 14.12 knots, our average revolutions being 118, which gave a slip of 13.3 per cent.

We did not indicate the engines on any of these trials, so that I can give you no data as to H. P., other than I should assume that we were developing on the first trial about 2,200 H. P., on the second trial about 2,100 H. P., and on the third trial about 1,950 H. P.

The keel is carried straight back to the rudder pintal in the usual way, and there is no well or opening through the deadwood abreast of the wheels.

*A technical description of the Niagara, with plans, will be found in our issue of April 1898.—Editor.

Lake Ships for Atlantic Coast Trade.

Considerable interest and speculation has been created during the past few weeks among vessel owners on the Great Lakes and along the Atlantic coast, by a large movement of lake vessels to the coast for use in the coal trade.

Several weeks ago Walter S. Besse, General Manager of the Atlantic Transportation Company, with offices in New York, made his appearance rather suddenly at Cleveland and very quietly, but in a remarkably short time, secured options from a number of lake vessel owners for the chartering of their boats for a term of years for coast trade service. The proposition was one quite new and was looked upon with considerable incredulity by the lake owners; but, as Mr. Besse was able to convince them of the excellent financial standing of his company, and, as most of the vessels desired were of the class that are fast becoming obsolete as dividend producers on the lakes, the options were readily given. As soon, therefore, as Mr. Besse had convinced himself, by a personal inspection of the locks and rapids through which the boats must pass in going from the lakes to the coast, that the scheme was practical, formal charters were closed for thirty-nine schooners and four steamers, the schooners ranging in size from

a capacity of 1,200 gross tons of coal to 2,500 gross tons, and the steamers from a capacity of 1,700 tons to 2,500 tons. The vessels are all of the older type of wooden ships. Charters are for terms ranging from two to five years, and include an agreement to keep the vessels insured on an agreed valuation and securing from the owner the option of purchase at any time during the charter term.

The Atlantic Transportation Company has a four year contract with the Chesapeake & Ohio Railroad Company for the transportation of all the latter's coal from Newport News to New York and New England ports, and it is in the handling of this business that these vessels will be used, together with a large fleet which the company already owns and has under charter.

The result of the advent of these vessels on the coast is problematical, as the vessels are to be used only in the transportation of coal controlled by this company; but the introduction of this extra tonnage will undoubtedly have more or less effect upon the business done by vessels in the coast trade.

The result on the lakes will undoubtedly be more marked, as the taking of so large a tonnage from the lakes (70,000 tons carrying capacity) at this time of year, when shippers are crowding their products forward in order to clear up the business of the year before the closing of navigation, and at the time of year when rates almost invariably advance, will undoubtedly make this advance more marked, and will, in all probability, induce the building of several new and modern lake carriers.

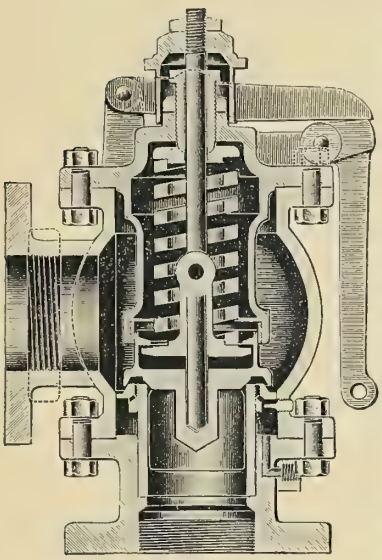
There is here printed a complete list of the vessels chartered, their respective tonnage, and the valuations placed upon them and owners:

Steamers.	Capacity Net Tons.	Insurance Valuation.	Chartered From.
Aragon	2,500	$100,000	C. R. Jones, Cleveland
Lindsay	1,700	68,000	C. R. Jones, Cleveland
Katahdin	2,200	100,000	H. W. McCormick, Bay City
Murphy, S. J.	2,200	100,000	L. H. McCormick, Menominee
Barges.			
Foster, Chas.	2,000	25,000	J. C. Gilchrist, Cleveland
Georger, F. A.	1,700	18,000	" "
Alverson, H. D.	1,500	18,000	" "
Moonlight	1,500	17,000	" "
Crosthwaite, W. S.	1,400	14,000	" "
Sheldon, T. P	1,300	14,000	" "
Bacon, M. S	1,300	18,000	" "
Watson, S. L.	1,200	12,000	" "
Foster, S. H.	1,300	16,000	" "
Verona	1,400	15,000	" "
Camden	1,400	15,000	Jno. F. Wedow, Cleveland
Halloran	1,500	16,000	Thos. Murphy, Cleveland
Massasoit	1,200	14,000	Leander Burdick, Toledo
Sage, H. W.	1,500	20,000	Jno. Kelderhouse, Buffalo
Redwing	1,500	16,000	A. A. Parker, Detroit
San Diego	1,500	16,000	" "
Iron State	2,000	30,000	J. W. Millen, Detroit
Iron City	1,200	22,500	" "
Watson, S. V. R.	1,000	10,000	Byron Whitaker, Detroit
Parker, Thos. L.	1,200	20,000	C. W. Elphicke, Chicago
Wadena	2,100	35,000	Mack-Becker Fleet, Cleveland
Becker, W. D.	2,100	48,000	" " "
Ash, Annie M	2,500	46,000	" " "
Checotah	1,400	16,000	Alvin Neal, Port Huron
Wallace, David	1,800	27,000	David Wallace, Lorain
Wall, Charles	1,200	9,000	C. R. Jones, Cleveland
O'Neil, John	1,200	10,000	" "
Brunette	1,400	12,000	" "
Shawnee	1,200	10,000	J. W. Westcott, Detroit
Hawgood, H. A.	2,300	42,500	Hawgood & Avery, Cleveland
Ewen, F. D.	1,900	32,500	" " "
Fitzpatrick, J. C.	2,400	55,000	Thos. Fitzpatrick, Cleveland
Metacomet	1,500	18,000	Inter Ocean Trans. Co., Milwaukee
Rutter, J. H.	1,800	25,000	Thos. Adams, Detroit
McGregor, Wm.	1,500	17,000	Northwest Trans. Co., Detroit
Brown, H. H.	1,500	17,000	" " "
Porter	1,500	16,000	C. A. Chamberlin, Detroit
Helvetia	1,600	18,000	H. J. Johnson, Cleveland
Page, M. W.	1,400	16,000	V. Fries, Milan, Ohio
	69,500	$1,184,500	

The Thingvalla Line has been purchased by the United Steamship Co., of Copenhagen, and will in future be known as the Scandinavian-American Line. A regular service between New York, Christiania, Copenhagen and Stettin will be maintained with the old fleet, which includes the steamships Hekla, Norge, Island and Thingvalla. The new owners announce that a fleet of new and fast ships will be built.

IMPROVED APPARATUS.

Improved Pop Marine Safety Valve.



MARINE SAFETY VALVE.

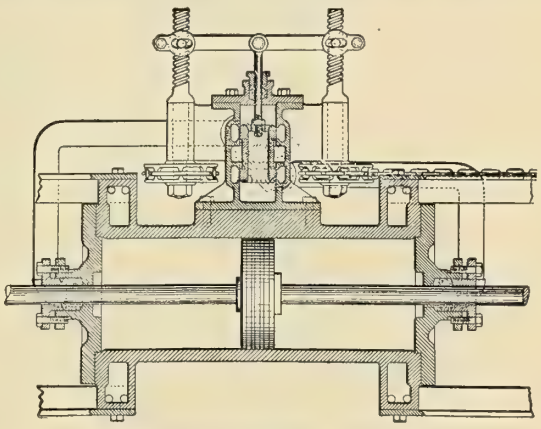
A section of the Scott improved Marine Pop Safety Valve here printed shows the method of construction. This valve is made with a bevel seat to an angle of 45 degrees, and is provided with a cam lever for raising the valve off its seat when no pressure is on, or blowing off all the steam when desired, as required by the rules and regulations of the United States Board of Supervisors and Inspectors of Steam Vessels. It has been approved by the Treasury Department on a basis of one square inch of valve area to two square feet of grate surface. It is so constructed that the spring is isolated from the steam. The outlet of the valve can be piped to any desired point of discharge, such as into the condenser hot-well, supply tank, or through the side of the ship and under the water-line, thereby dispensing with the noise while blowing off, and without affecting the efficiency of the valve or changing its point of opening or closing. Access to the valve can be had without interfering with outlet pipe. This valve is manufactured by the Roe Stephens Mfg. Co., Detroit, Mich.

Waters Steam Steering Engine.

A direct acting steam steering engine is manufactured by George H. Waters, which is guaranteed to hold the rudder in any position and to be perfectly noiseless. It is a compact form of gear which can be hung from the deck so that the floor space underneath is clear of any obstruction. The valve and cylinder mechanism is clearly shown in the accompanying engraving. At either end the piston rod is attached to a traveling block working in a frame on slides and these blocks carry the rudder chains. The objection of "condensation" which is made to steam "direct gears" is met by an arrangement which, according to the inventor, insures accuracy of the gear when the wheel is held long in one position. The steam valve is moved from the pilot house to admit steam to either end of the cylinder, according to the direction required, and the piston in response moves to a certain point, according to the amount of opening given the valve. While the piston is moving to this point it moves a chain attached to the piston rod, or to the traveling block, and working over a chain wheel attached to the governor side of the valve. The movement of this chain wheel brings the valve back to a central position at all times. In case the hand wheel in the pilot house should be held in one position for a considerable length of time, and the piston was to shift from condensation it would simultaneously move the chain wheel on the governor side and admit steam so that the piston would be moved back to the original position. These gears are guaranteed to be very economical in the use of steam. One of them is in use on the Erie Railroad Ferryboat John King, in the North River, and is said to have given complete satisfaction. The address of the inventor and patentee, George Waters, is 201 River St., Hoboken, N. J.

C. & C. Electric Generating Sets.

In response to an increasing demand for iron-clad dynamos connected to Forbes vertical engines the C. & C. Co. has recently designed a full line of such sets, ranging in capacity from $3\frac{1}{2}$ to $16\frac{1}{2}$ K.W. which are now ready for the market. Several of these outfits have already been sold and placed in operation with highly satisfactory results. The Forbes engine has been designed with the idea of producing an engine simple in its construction, large in its wearing surfaces, close in its regulation and in fine running balance. The makers have not resorted to



WATERS STEERING ENGINE.

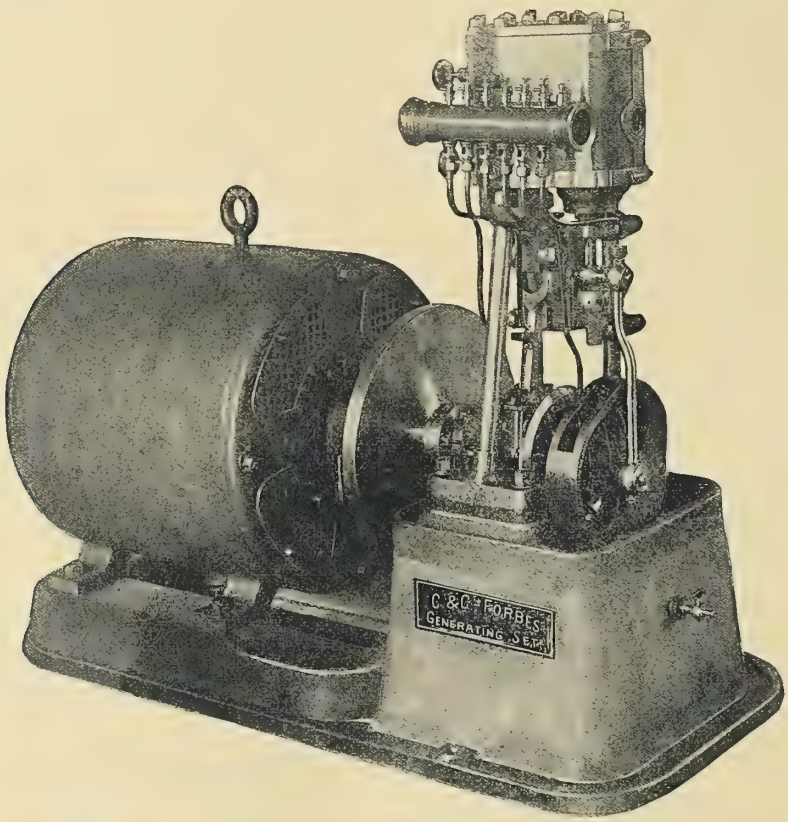
any cheap workmanship or material, feeling sure that nothing but the best should be used in a high speed engine. All the forgings are of steel, forged without welds, metallic packing is used on valve stems and piston rod, and the governor is made under the Rites patent. The lubricator is easily adjusted and thoroughly efficient. While sacrificing nothing in the way of strength it is the lightest engine for its horse-power commercially made. The dynamo employed in these sets possesses many recommend-

ations for marine work, where dynamos are as a rule put in close quarters and where the machine is often liable to injury either through accident or through becoming wet. The cylindrical field frame of the dynamo, which forms the largest part of the casing, is of soft cast steel in one piece with the four pole pieces. The two end plates which are bolted to this case or frame carry the two self-oiling and self-aligning bearings, besides one of them carrying on the commutator end a shoulder to which is secured the brush holder spider. The field coils are carefully wound on metal spools or bobbins, and the whole well insulated. The armature is most substantially built and is well arranged for ventilation, while the commutator is of ample proportion, and its segments of 98 per cent copper.

chine where it is absolutely inclosed to keep the heating effect within safe limits. For example, the same frame which is wound for 5½ K.W. as an open type, is wound for 4½ K.W. where the machine is to be closed. The closed type is entirely dust proof and waterproof, and particularly adapted for steamer lighting, yet the open type fills most requirements equally as well. In the illustration here shown, the open type dynamo is used. The outfits are manufactured by the C. & C. Co., 143 Liberty street, New York.

Pumps for Lake S.S. S. F. B. Morse.

The illustrations show two steam pumps made by Dean Bros. Steam Pump Works for the Bessemer Steamer S. F. B. Morse, the largest vessel on the Great Lakes. The boiler feeder

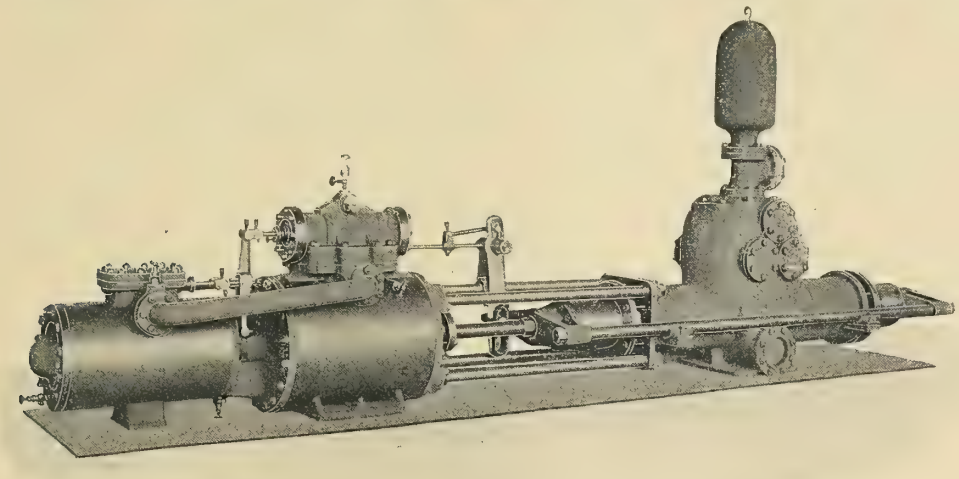


C. & C. DYNAMO AND FORBES' ENGINE—DIRECT CONNECTED.

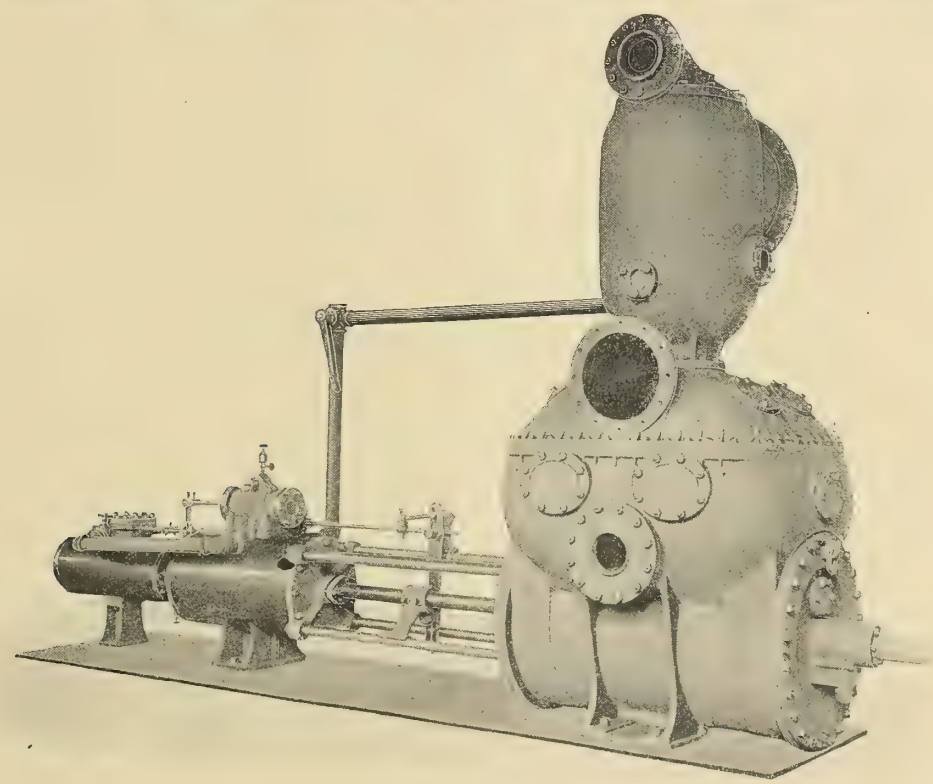
Brush holders are of the well known "improved reaction" type, through which just the proper tension is at all times applied to the carbon brushes. The design and operation of this dynamo are both so calculated that no brush movement is required under any load or load change, and there is no objectionable sparking at the brushes. In neither the closed or the open type is there any injurious heating. Both types are the same, except that in the open type the four openings in each end plate are fitted with perforated hand plates, while in the closed type these plates are solid. Of course, it is necessary to be more conservative in the rating of the ma-

has compound steam cylinders and outside packed plungers. The high pressure steam cylinder is 12 in. dia., low pressure cylinder 13 in. dia. by 20 in. stroke. The pump end is of the "trombone" pattern with bronze plungers 10 in. dia. by 20 in. stroke. The plunger cross heads are of cast steel. As the working steam pressure is 200 lbs. per square inch the pump cylinder is cast in one piece to avoid danger from leaky joints. The air pump and condenser has compound steam cylinders 10 in. and 16 in. dia., by 30 in. stroke. The air pump cylinder is double acting, 30 in. dia. by 30 in. stroke. It is lined with heavy bronze and has

bronze piston rod. At the outer head it is provided with a bronze tail rod for carrying the weight of the piston. The shoe to tail rod has external means for adjustment in case of wear. In the cylinder head there is a hand hole plate for examining the inside of the cylinder without removing the head. The flange shown on the side of the cylinder is for the bilge pipe connection, so that in an emergency the air pump may be used as a water pump for pumping out the vessel. The exhaust pipe from the steam cylinder is carried into the condenser, it has a three way cock with a lever for changing the exhaust to the open air if necessary. The propelling engine from which the condenser takes steam is of the quadruple-expansion type with cylinders 26 1-2 in., 37 in., 54 1-2 in. and 89 in. dia. and 42 in. stroke. All of the other pumping machinery for this lake carrier, including two ballast pumps, one fire pump, one bilge pump and a cooler pump, was furnished by Dean Bros. Steam Pump Works, Indianapolis.



DEAN BOILER-FEED PUMP FOR LAKE S.S. S. F. B. MORSE.



DEAN AIR PUMP AND CONDENSER FOR S.S. S. F. B. MORSE.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building, New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.
S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representative.
L. L. CLINE, Detroit, Mich., 47 Hodges Building.

Traveling Representatives.
E. L. BLANCHARD. J. E. WHITTLESEY.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

UNUSUAL interest attaches to the forthcoming meeting of the Society of Naval Architects and Marine Engineers in consequence of the recent naval operations in the Spanish war. The Society has made arrangements, indeed, for a very complete discussion of problems in construction and operation of naval vessels upon which original information has been had in blockade duty and sea fights, chiefly in the Caribbean Sea. November 10 and 11 are the days of the meeting, and through the courtesy of the American Society of Mechanical Engineers the members will come together in the auditorium at 12 West Thirty-first street, New York. The list of papers to be read each day contains in itself many professional matters of timely interest, and this is added to by the selection of the subjects for topical discussion. For Thursday, November 10, the programme, arranged by Sec.-Treas. Francis T. Bowles, reads:

1. Torpedo-Boat Destroyers for Sea Service, with Special Reference to the Conditions that Prevail on the Pacific Coast.

By G. W. DICKIE, Esq., Member.

2. The Standard Navy Boats.

By ARTHUR B. CASSIDY, Esq., Member.

3. Bilge Keels and Rolling Experiments U. S. S. Oregon.

By Asst. Naval Constructor LAWRENCE SPEAR, U. S. N., Member.

4. Steam Economy Test of a Unique Form of Feed Pump.

By F. M. WHEELER, Esq., Member.

5. Portable Pneumatic Riveters in Shipbuilding.

By W. I. BABCOCK, Esq., Member.

Topical discussions of the following questions:

1st. The utility of Torpedo-Boats, and has the Sub-Marine Boat a place?

2d. In what respects have the recent Naval Engagements affected opinion as to the value and best distribution of armor for war-ships?

For the day following, Friday, November 10, the list includes:

6. The Steam Yacht as a Naval Auxiliary.

By WILLIAM P. STEPHENS, Esq., Associate.

7. Designs of the New Vessels for the U. S. Navy.

By Chief Constructor PHILIP HICHBORN, U. S. N., Vice-President.

8. Methods of Securing Water-tight Work.

By Asst. Naval Constructor H. G. SMITH, U. S. N., Associate.

9. Tests of the Strength of a Longitudinal Bulkhead Separating Two Engine Rooms.

By Naval Constructor J. J. WOODWARD, U. S. N., Member.

10. An Electrically Operated 150 Ton Revolving Derrick.

By WALTER A. POST, Esq., Associate.

11. Stability of a Battleship under Damaged Conditions.

By Prof. CECIL H. PEABODY, Member.

Topical discussions of the following questions:

1st. Under the circumstances of the Blockade at Santiago, which was the more economical method of maintaining the boilers in readiness for immediate action—banking the fires or keeping them spread but very thin?

2d. Can you give any data as to the cost in coal of maintaining the engines and boilers in readiness for immediate service?

3d. What, if any, difficulty was there in maintaining the supply of fresh water for the boilers; and, if there was any difficulty, to what do you attribute it?

4th. As a result of experience on the Blockade, what particular points about the machinery were most likely to give trouble, and what could be done to prevent a recurrence of such trouble?

Present indications are that this, the sixth annual meeting will be probably the most largely attended ever held by the Society. Every member who can possibly attend will find in this meeting the pleasantest experience of the year, and others who are interested, will, as guests of the Society, be cordially welcomed and given opportunity to take part in the discussions.

OF special interest are the official returns covering domestic shipbuilding and merchant shipping for the year ending June 30 last, prepared in the office of Mr. E. T. Chamberlain, Commissioner of Navigation, Treasury Department, Washington. These will soon be published in the regular annual report. Meanwhile we give an abstract of the complete returns, which show that the documented American merchant shipping on June 30, 1898, comprised 22,705 vessels of 4,749,738 gross tons, compared with 22,633 vessels of 4,769,020 tons on the like date in 1897. The decrease of 19,282 tons is more apparent than real, as 11,000 tons of this amount is due to dropping fractions of tonnage in the accounts, and 66,713 tons were sold to the Navy and War Departments to carry troops, supplies and provisions, and have merely changed employers. The total steam tonnage amounts to 6,712 vessels of 2,371,923 tons, compared with 6,599 vessels of 2,358,558 tons for the previous year. The vessels sold to the government were all steam vessels, so the true increase is greater than the figures indicate. Sailing vessels have decreased from 1,904,153 tons for 1897 to 1,835,827 tons for 1898. Documented canal boats and barges amount to 541,988 tons, compared with 506,309 tons for the previous year. The increase is chiefly in barges which are superseding sail vessels, especially in the coal trade. Tonnage on the Atlantic and Gulf coasts has dropped from 2,647,796 tons for 1897 to 2,553,739 tons for 1898. The Great Lakes tonnage shows a slight increase, 1,437,500 tons compared with 1,410,103 tons. The new Alaskan trade has increased the Pacific coast marine from 439,012 tons to 496,767 tons. Western rivers have decreased from 272,109 tons to 261,732 tons. New York State retains the first place with tonnage reduced from 1,331,743 to 1,299,825 tons, Michigan is still second with a reduction from 477,602 to 458,100 tons, and Ohio stands third with 395,618 tons, an increase of about 6,000 tons. The greatest increase is in Washington, from 97,796 to 152,167 tons, and Alaska from 3,824 to 9,755 tons. New England shows a large decrease, and the Gulf States an appreciable increase. Vessels registered for foreign trade number 1,136 of 737,709 tons, compared with 1,230 of 805,584 tons for 1897. These figures are the lowest since 1832. The decrease is wholly in sail vessels of which 159 of 103,000 tons, or about 20 per cent have been lost, laid up or gone into domestic trade during the year. Registered steam vessels have increased from 222,136 tons to 245,059 tons. Through the greater efficiency of steam vessels our fleet for the foreign trade does not show a decrease in carrying power. The effect of the war is shown in the sale of 84 vessels of 35,411 tons to foreigners, compared with sales of 8,243 tons the previous year. The sales were chiefly due to high premiums on American vessels and cargoes, demanded by insurance companies during the brief period while mines and torpedoes were being placed in our harbors. The effect of the war is also shown in the admission by Acts of Congress of 27,824 tons of foreign vessels to American registry, chiefly for transport purpose. During the preceding eight years only 55,902 tons were so admitted. New documented tonnage constructed during the fiscal year ending June 30 last included 952 vessels of 180,458 tons as compared with 891 vessels of 232,233 tons during the previous year. An analysis of these figures showing the general

Geographical Distribution.	1897.		1898.	
	No.	Gross Ts.	No.	Gross Ts.
Atlantic and Gulf coast...	609	96,009	514	63,090
Pacific coast	64	7,495	228	49,789
Northern lakes.....	120	116,937	87	54,084
Western rivers	98	11,792	123	13,495
Total.....	891	232 233	952	180,458

Power and Material.	1897.		1898.	
	No.	Gross Ts.	No.	Gross Ts.
Sail:				
Wood.....	327	29,678	357	27,692
Steel	11	34,631	2	6,724
Steam:				
Wood.....	244	27,917	343	57,337
Iron and steel.....	44	78,236	51	48,501
Canal boats.....	70	10,216	20	2,386
Barges:				
Wood.....	182	40,027	169	30,777
Steel	13	11,528	10	7,041
Total.....	891	232 233	952	180,458

location of the yards, the materials of construction, and the form of power employed is printed in the tables herewith. There is now a great deal of activity in shipping circles, and building orders are plentiful in most of the Atlantic coast yards. Treasury Department statistics of commerce for nine months of this year, ending September 30, show that it will be a record breaker in the total of exportations. For the period between January 1 and September 30, 1898, the exports footed up $869,127,868, or $122,889,626 more than the figures for 1897.

CORRESPONDENCE.

[*Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.*

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

Comment on Mr. Kyles's Paper on Marine Engine Repairs.

Editor Marine Engineering:

In your July issue I notice the extract fom a very interesting paper read before the Institute of Engineers and Shipbuilders of Hong Kong, by J. Kyles. M. E., entitled "Marine Engine Repairs Discussed in a Thoroughly Practical Way." While I fully agree with him in many particulars, there are certain methods described which appear antiquated in the light of the best practice here (transatlantic trade), and in other instances the author might, I believe, have given more details than are contained in the paper.

In the first place, in the item *Repairs to Cylinders*, the question is raised as to what is to be done with the piston after the cylinder has been rebored. The treatment as described consists in shrinking on a wrought iron or mild steel hoop with a V groove to prevent its coming off, and turning down the same to 1-32 inch smaller in diameter than the cylinder. This evidently refers to the lip of the piston, the repair, no doubt, including a new follower and packing rings.

The lip of the piston acts in the capacity of a solid piston ring as long as it fits the cylinder, but as soon as it gets slack it loses all its usefulness, except when supporting packing rings, and in that case a part of the lower packing ring is subjected to the full blast of steam at admission, which soon destroys the fit of the latter.

The better way of altering the piston after the cylinder is rebored consists in turning down the lip to a size of about 2 inches less in diameter than the cylinder, and let the new follower lap over it to the full depth of the piston. The follower bolts are usually strong enough to bear the pressure on the exposed edge of it on upstroke. The packing rings are then placed in the follower, and can be very easily overhauled by disconnecting the follower from the piston and lifting it out of the cylinder. In regard to Ramsbottom rings, it is the rule not to put spring rings behind them in cylinders less than 75 inches in diameter.

The following item, *Crankshaft Construction*, contains a detailed description of putting a new crankpin in the webs of a built-up crankshaft so as to get it true. Now for heavy, large jobs there is no use in running any risk of this kind; for the journals as well as the pins, bore out the holes in the webs somewhat larger, shrink in the pin or journals, and then turn them down to the proper sizes, and the shaft will be true. In connection with the subject of shafting, Mr. Kyle states that the coupling-bolt holes in new spare shafts are usually 1-4 inch smaller in diameter to allow for reaming, and suggests that it would save time if the shaft were taken to a machine to have the holes enlarged instead of doing it on board with the reamer.

I do not see why there is any occasion for the holes being so small. Every ship has, or ought to have, a template of the bolt holes in the couplings, as the holes are all laid out from a template when the engine is building; 1-16 inch is ample allowance, especially when it is considered that the old holes in the adjoining coupling will also be slightly reamed at the same time. The handling of a 15 ton crankshaft is a rather expensive operation, and the removal of a defective shaft and the installation of the spare one is very laborious, even when conditions are favorable.

Mr. Kyles asserts that 1-4 inch taper to the foot on a coupling bolt is entirely too little. Present practice demonstrates that 3-16 to 1-4 inch to the foot is ample. On a coupling flange, say 4 1-2 inches thick, with coarse taper bolts of proper shearing section, the large ends of the bolts diminish the section of coupling material at their pitch circle to the extent of causing weakness or fracture.

In the item, *Piston Rods*, Mr. Kyles deplores the fact that there is usually too little shoulder left where the piston butts on the rod, so that when the rod requires turning up there is no shoulder left, or if a collar is left, the gland and neck-bushes must be made in halves.

Evidently this case applies to piston rods which have a jaw holding the crosshead brass, a rather antiquated design for large jobs, as there is much labor entailed in removing or disconnecting such a rod. Even if the rod were trued up to the extent of removing the shoulder, there is no plausible reason why a good fitting taper on the rod should not hold a moderate sized piston perfectly secure without the assistance of a shoulder. In modern practice the use of a taper on a piston rod to hold the piston is gradually being abandoned, especially for large diameter cylinders, and instead a flange coupling is put on the end of the rod, holding the piston by means of fitted bolts, the stuffing-box plug in the bottom of the cylinder being made large enough in diameter to draw the rod out from below. The rod is attached to the crosshead with a taper and nut. With this construction it is very easy to take out a rod and put on glands and neck-bush without removing the piston, and it can be most appreciated when overhauling engines where two cylinders work tandem.

On the subject of *Valve Faces* the author of the paper suggests that in order to get good metal in a false valve face it is a good plan to cast the face solid and machine out the ports. To make this a general rule would be going to extremes. Where the ports have sharp corners or small fillets it is not a difficult matter to judge where cooling cracks are liable to occur, and if the face is cast with large fillets at the ends of the ports and in the strengthening bars between the ports, also with the width of the ports 1-4 or 1-2 inch smaller than the finished size, and then machine it to the correct size, far less labor and time will be required to attain the same result.

In the item, *Piston Valves*, it is suggested that valves over 12 inches in diameter should have split rings. Experience has proved that spring rings on piston valves always cause the chambers to wear rapidly and out of round, destroying the precision of the cut-off and exhaust edges of the valves. Large valves should have a neatly fitted cast iron floating ring held in position by the follower, the ring being the full depth of the working face. Such a ring will be practically steam tight for a long time, and it is an easy matter to replace it by a new one when necessary.

Writing of *Eccentric Straps*, Mr. Kyles states that the top half of the eccentric strap liner often requires renewal, while the bottom half is very little worn, and suggests making the bottom half of the strap the same as the top to suit the foot of the eccentric rods, so that in case the top half is badly worn the strap simply requires to be turned upside down. There is no objection to this, but in a difficulty of this kind would it not be better to look a little more closely into the root of the trouble and install a balance piston, or bore out the chamber of the existing balance cylinder to give it more area so that the strain will not be entirely on the top half of the strap?

In discussing *Feed and Bilge Pump Plungers*, Mr. Kyles mentions a quick repair to the cast iron valve

chest of a bilge pump. He recommends that when the casting is so badly corroded that new valve seats cannot be introduced, a brass cage with ports be made to hold the suction and delivery valves, the cage to be set in the casting and held in place by the cover of the chest. This would only prolong the evil, for it is evident that the galvanic action by the contact of the brass cage would soon eat away all the iron around it and cause an excessive leak between the suction and delivery chamber. In designing cast iron bilge pump chests an extra allowance should always be made for the depth of the bearing of the seat, but the bearing alone should never be depended upon entirely for holding the seat. The best design of valve seat in new jobs, as well as in repairs, is to attach a flange or lugs so that it can be bolted fast to the chamber. The bolt holes in the flange or lugs, as well as the body of the studs, to be square to prevent the studs backing out. The studs should be of brass, care being taken when drilling and tapping for them not to go entirely through the division plate; the flange of the seat to be set down on red lead putty. This job will usually last as long as the chest.

In his comment on *Miter, Fiber and Check Valves*, Mr. Kyles calls attention to the difficulty in getting fiber valves to work efficiently in an air-pump. The question of the style of valves for an air-pump, especially those in the bucket, has given rise to considerable controversy. It is evident, however, that the old style of cast brass valves is rapidly going out of use, as in modern engines, with high piston speed, the bucket strikes the water at the bottom of the pump with such a velocity that each cast valve acts like a small battering ram against the head of its stud; and even if the studs are made of the best bronze, they cannot stand this treatment very long, and the air-pump chamber is soon filled with small bits of pounded brass. The Kinghorn valve, consisting of several discs of their bronze plate placed one on top of the other, seems to be the only style of valve which gives good satisfaction under all conditions, and can easily be applied to almost any pump which has been originally fitted with common valves or fiber valves.

In the item, *Copper Piping*, Mr. Kyles states that a 6-inch spigot on a copper pipe is useless, as the brazing only makes a thoroughly strong job for 2 inches of its length. He could well have made this statement in a much more emphatic manner, as, for instance, that the attempt to do anything of this kind ought to be forbidden by law. Any increase over 2 inches in the depth of the spigot of a brazed flange not only renders the brazing insecure, but is almost certain to burn part of the pipe. In the best brazing jobs the hole in the flange is filleted out on the joint side, and the pipe is thoroughly hammered into the hole and the edge hammered out bell-mouth shape into the fillet, so that the copper forms part of the joint face of the flange. This makes the pipe secure in case any expansion or contraction should ever strain it to the extent of parting it at the brazing, and, in fact, pipes have been connected up this way without any brazing at all.

Under the heading, *Propeller Shafting*, Mr. Kyles complains that many establishments are far too careless in fitting propeller hubs to shafts. It is by no means an easy thing to make an excellent fit with a large cast iron steel hub with a bore 45 to 55 inches long, where the material is so hard that the boring tool is dull by the time the cut is finished, or has to be sharpened before it finishes, so that the bore is not perfectly true. In cases of this kind where the error is very slight the best policy is to have the best fit at the large end of the taper, as the face of the nut will hold the after end.

The author further states that if the bore is badly pitted, or is a poor fit, a good job can be made by reboring it and pinning in a steel liner 3-8 inch thick, holding it in place with a collar. This may be all right where there is an excess of strength in the parts, but as loose or partially sheared keys are not uncommon, the 3-8 inch of material interposed between the two solid shearing edges will lessen the efficiency of the key, and deepening the keyway will only weaken the shaft. The safest way is to rebore the hub, taking as little metal out as possible, then face off the forward end equal to the extra amount it will go forward on the shaft, and recess the nut at the end of the shaft. If any of these conditions cannot be fulfilled it would be safer to condemn the hub.

In regard to the protection from galvanic action on a propeller shaft at the end of the brass liner, the practice of soldering or pouring a white metal ring between the ends of liners, or between the end of a liner and an iron ring shrunk on the shaft, has been condemned as inefficient. Compressed pure rubber is now used extensively. In some cases the soft rubber is wrapped on the shaft between the liners and heated with a blow-lamp, and latterly the entire shaft is put in a heater and the rubber vulcanized. This seems to answer the purpose very well, but is an ever recurring expense whenever it becomes necessary to strip it off in order to survey the shaft. The place where the after liner butts against the hub is usually protected by a soft rubber ring, which is compressed by an annular lipped ring bolted to the hub in two halves.

Too much cannot be said concerning the protection of all working parts from the corrosive action of sea water. Tallow seems to keep out sea water very well, and all steel rudder pintle nuts, propeller nuts and blade stud nuts should be surrounded by a metallic casing which has been poured full of molten tallow and the holes plugged. HENRY L. EBSEN.

New York.

The Hamburg-American Line has placed an order with the shipbuilders, Blohm & Voss, of Hamburg, for the construction of a new twin-screw steamer, which is intended to be the largest cargo carrier in the world. The dimensions of this vessel are: Length on the water line, 600 ft.; breadth, 66 ft.; depth, 42 ft. The total capacity for cargo, exclusive of coal and stores, will be 14,000 tons of 2,240 lbs., or about 20,000 tons of 40 cubic feet. There will also be accommodations for passengers, of which this steamer will be able to carry 300 in the first and 200 in the second cabin, and 600 steerage. The steamer will be driven by two sets of quadruple-expansion engines, of a power sufficient to maintain a sea speed of 14 knots. The new vessel will be fitted with numerous water-tight bulkheads and double sides, the inner and outer bottoms being carried up above the water line. This space will be minutely subdivided, and will add greatly to the safety of the vessel in case of collision. The claim is erroneously made by the company that this feature has never been introduced in the construction of a merchant vessel. Forty years ago a vessel named the Great Eastern was constructed in England on this principle of subdivision, and she made several trips to the port of New York, with passengers and cargo.

"Verbal Questions and Answers Given at the Board of Trade Examinations for Engineers" is the title of a little 140-page book just published by A. Ritchie Leask, 95 Minories, London, Eng. Taking it as a whole, this is one of the most complete, though concise, books of instruction of the sort we have any knowledge of. It is a thoroughly practical little book, plainly written and illustrated and is strictly up-to-date, which cannot be said for many of the elementary books of the kind on the market. The English selling price is 2s 6d, and the author's American agents are Spon & Chamberlain, 12 Cortlandt street, New York.

MISHAPS AT SEA.

Loss of the Atlantic Transport Line Steamship Mohegan off the Lizard, England.

On the night of October 14 the Atlantic Transport Line steamship Mohegan went on the rocks off the Lizard, in the English Channel. The vessel is probably a total loss, she having sunk in a short time, leaving only the tops of the masts and smoke pipe above water. Unfortunately the loss of the vessel was accompanied by a serious loss of life. There were on board about fifty-three passengers and ninety-one crew, and of these there were saved about eleven passengers and thirty-eight of the crew. Captain Griffiths, the commander, went down with his ship, and not any of the navigating officers was saved.

How the vessel could have got into the position where she was wrecked is inexplicable at this time. and in view of the loss of the deck officers it is doubtful if any court of inquiry can answer it. She was clearly off her course, in a channel which is well protected with powerful light houses, so that navigation there is largely a matter of pilotage. There are some strong currents there, but to a navigator experienced in those waters there does not seem to have been any special reason why he could not have kept off shore. When the mishap occurred the weather was clear, though a strong southeast wind was blowing. According to cabled reports of survivors, the captain and crew behaved like seamen after the vessel struck. Prompt efforts were made to load passengers into the boats and lower them over the sides. The ship sank quickly, however, and during this time her decks were inclined at a steep angle as she settled by the head, so that the difficulty of launching was greatly increased. Two life boats are said to have got away and subsequently been capsized because there were not enough sailors in each to properly man them.

So far as the passengers were concerned, there was no warning given of the mishap. Most of them were in the saloon at dinner when the Mohegan went on the rocks. Among those saved was John Hyslop, of New York, the widely known official measurer for the New York Yacht Club. A noble feature of this sad mishap was the work done by the lifeboat crew of Port Houstock, Cornwall, which put out and saved many lives. Some of the survivors who had on life belts were washed ashore and others were saved by holding on to pieces of wreckage.

The Mohegan was owned by the Atlantic Transport Line, sailing on the regular schedule between New York and London, under the British flag. She was west bound when lost. She was a new vessel, having been built recently as one of the fleet of the Wilsons-Furness-Leyland line and christened the Cleopatra. When the Atlantic Transport Line sold its fleet to the United States Government for use in transporting troops, it in turn purchased the entire fleet of the Wilsons-Furness-Leyland line, as readers of our August issue will recollect. As the Atlantic Transport Line's ships all have names commencing with the letter M, the new liners acquired were renamed the

ATLANTIC TRANSPORT LINE STEAMSHIP MOHEGAN, LOST OFF THE LIZARD ON THE NIGHT OF OCTOBER 14, 1898.

Mohegan, Marquette, Mesaba, Menominee and Manitou. The Mohegan (originally Cleopatra) was built by Earle's Shipbuilding Co., of Hull, and was launched April 6. She was the largest vessel ever built at that port and measured 482 ft. in length, 53 ft. in width and 34 ft. 6 in. in depth, molded to upper deck. Above this for the entire length there extended a shelter deck and above this again there was, amidships, a bridge deck 150 ft. long, on which there was a steel house 130 ft. long and 36 ft. wide. The top of the house was carried out to the sides and supported by stanchions. The platform thus formed served the purposes of carrying the boats and affording shade to the bridge deck, and at its forward end there was the pilot house and chart room. Still higher up there was a flying bridge over the wheel house. This entire superstructure was for the accommodation of the officers and passengers, and while it gave the ship a rather unsightly appearance, it was a comfortable resting place for the ocean traveler, especially in rough weather. There were berths for 120 saloon passengers, the only class this line carries, and the passengers' quarters were spacious and very handsomely fitted up. One hundred persons could sit down together at dinner in the main saloon. Forward there was the usual accommodation for the crew and quarters for cattlemen, the vessel being fitted to carry a great many head of cattle under the shelter deck.

As the vessel was not intended for high speed, her engines were of 5,000 I.H.P., capable of driving her at the rate of 15 knots at sea. She was a single-screw vessel, and the engines were of the three-crank triple-expansion type, taking steam at 200 lbs. pressure from two double-ended and one single-ended boilers, fitted with Howden draft.

Her general appearance when at sea is shown in the drawing (port bow) made by our artist. She was a well-fitted and found vessel, and rated in the highest class at Lloyds. She had begun her second voyage only when she was wrecked.

The loss of the S.S. Maracaibo, of the Red D Line, was reported last month. She was engaged in the trade between Venezuelan ports and the Windward Islands. She sailed from New York, October 4, for Ponce, Maracaibo and Curacoa, with a general cargo and passengers. She called at Ponce and Curacoa and landed her passengers and sailed for Maracaibo, October 13. She went ashore on Paraguana Peninsula, Venezuela. Captain Reitt and the crew were saved. The Maracaibo was built at Philadelphia, at Hillman's yard, in 1889. Her dimensions were: Length, 231 ft; beam, 43 ft., and depth, 13 ft. 6 in. Her gross tonnage was 1,262 tons. She was schooner rigged and was fitted with triple-expansion engines.

The British ship Blengfell, with a cargo of case oil from New York, took fire on the morning of October 7, when about four miles off Margate, on the southeast coast of England, and was a total loss. The fire followed an explosion, which blew out the stern of the ship, and probably killed the captain and pilot and two officers, who were reported missing. A tug was alongside at the time, making ready to take the ship in tow, and she rescued twelve of the crew. The Blengfell was a three-masted iron ship of 1,210 tons, built in 1876, and owned in Liverpool. Her dimensions were: Length, 234 ft. 4 in.; beam, 35 ft. 2 in., and depth, 21 ft. 1 in. She sailed from New York September 19 with a cargo of 329,300 gallons of case oil, consigned to London parties. Balfour, Williams & Co. were her agents in New York.

George Clarke, formerly a member of the executive staff at Newport News Shipyard, has been appointed consulting engineer to the Quartermaster's Department of the U. S. Army, in the transportation department, with headquarters at New York.

EDUCATIONAL DEPARTMENT.

CALCULATIONS FOR ENGINEERS—AN AID TO CANDIDATES FOR MARINE PAPERS—II.

BY DR. WILLIAM FREDERICK DURAND.

§4. COMPOUND NUMBERS.

Weights and Measures.

[1] LONG OR LINEAR MEASURE.

Inches.	Feet.	Yards.	Rods.	Furlongs	Miles.	Meters.
1	.0833	.0278	.01515	.000126	.000016	.0254
12	= 1	.333	.0606	.00152	.000189	.305
36	3	= 1	.182	.00455	.000568	.914
198	16½	5½	= 1	.025	.00313	5.029
7920	660	220	40	=1	.125	201.166
63360	5280	1760	320	8	=1	1609.3
39.371	3.281	1.094	.199	.00497	.000621	= 1

SPECIAL MEASURES.

6	feet	= 1 fathom.
120	fathoms	= 1 cable's length.
6080.27	feet	= 1 nautical mile (United States).
6080	feet	= 1 nautical mile (British).
3	nautical miles	= 1 marine league.

[2] AVOIRDUPOIS WEIGHT OR MEASURE.

Drams.	Ounces.	Pounds.	Tons.		Kilos.
			Long or British.	Short or Legal.	
1	.0625	.0039	.....	.....	.....
16	= 1	.0625	.....	.....	.02835
256	16	= 1	.000446	.0005	.4536
573440	35840	2240	= 1	1.12	1016
512000	32000	2000	.89	= 1	907
564.38	35.27	2.2046	.000984	.001102	= 1

[3] SQUARE MEASURE.

Square Inches.	Square Feet.	Square Yards.	Square Meters.
1	.00694	.000772	.000645
144	=	.1111	.0929
1296	9	= 1	.8360
1550	10.765	1.196	= 1

[4] CUBIC OR VOLUME MEASURE.

Cubic Inches.	Cubic Feet.	Cubic Yards.	Cubic Meters.
1	.0005788	.....	.....
1728	= 1	.037	.0283
46656	27	= 1	.7645
61033	35.32	1.308	= 1

[5] LIQUID MEASURE.

Cubic Inches.	Gills.	Pints.	Quarts.	Gallons.		Barrels.
				U. S.	British.	
1	.1154	.02885	.0144	.00433	.00361	.....
8.665	=1	.25	.125	.03125	.3125	.....
34.659	4	=1	.50	.125	.125	.....
69.318	8	2	=1	.25	.25	.....
231	32	8	4	=1	.833	.003175
277.274	32	8	4	1.2	=1	.003175
....	1008	252	126	31½	31½	=1

[7] SHIPPING MEASURE.

1 register ton	=	100 cubic feet.
1 United States shipping ton	=	40 cubic feet or 32.14 United States bushels.
1 British shipping ton	=	42 cubic feet or 32.72 imperial bushels.

[6] Dry Measure.

Cubic Inches	Pints.	Quarts.	Pecks.	Bushels.
1	.02976	.01488	.00186	.0004641
33.6	=1	.5	.0625	.015625
67.2	2	=1	.125	.03125
537.6	16	8	=1	.25
2150.42	64	32	4	=1

[8] **The Metric System of Weights and Measures.**

Measures of Length.

10 millimeters (mm)	= 1 centimeter	cm.
10 centimeters	= 1 decimeter	dm.
10 decimeters	= 1 meter	m.
10 meters	= 1 dekameter	Dm.
10 dekameters	= 1 hektometer	Hm.
10 hektometers	= 1 kilometer	Km.

Measures of Surface (Not Land).

100 square millimeters (mm^2)	= 1 square centimeter	cm^2.
100 square centimeters	= 1 square decimeter	dm^2.
100 square decimeters	= 1 square meter	m^2.

Measures of Volume.

1000 cubic millimeters (mm^3)	= 1 cubic centimeter	cm^3.
1000 cubic centimeters	= 1 cubic decimeter	dm^3.
1000 cubic decimeters	= 1 cubic meter	m^3.

Measures of Capacity.

10 milliliters (ml)	= 1 centiliter	cl.
10 centiliters	= 1 deciliter	dl.
10 deciliters	= 1 liter	l.
10 liters	= 1 dekaliter	Dl.
10 dekaliters	= 1 hektoliter	Hl.
10 hektoliters	= 1 kiloliter	Kl.

Note.—The liter is equal to the volume occupied by 1 cubic decimeter of pure distilled water at its temperature of maximum density, or 39.2° F.

Measures of Weight.

10 milligrams (mg)	= 1 centigram	cg.
10 centigrams	= 1 decigram	dg.
10 decigrams	= 1 gram	g.
10 grams	= 1 dekagram	Dg.
10 dekagrams	= 1 hektogram	Hg.
10 hektograms	= 1 kilogram	Kg.
1000 kilograms	= 1 ton	T.

Note.—The gram is the weight of 1 cubic centimeter of pure distilled water at a temperature of 39.2° F.; the kilogram is the weight of 1 liter of water; the ton is the weight of 1 cubic meter of water.

[9] **Conversion Tables.**

English Measures into Metric.

English.	Inches to Millimeters.	Feet to Meters.	Pounds to Kilos.	Gallons to Liters.
1	25.4001	.304801	.45359	3.78544
2	50.8001	.609601	.90719	7.57088
3	76.2002	.914402	1.36078	11.35632
4	101.6002	1.219202	1.81437	15.14176
5	127.0003	1.524003	2.26796	18.92720
6	152.4003	1.828804	2.72156	22.71264
7	177.8004	2.133604	3.17515	26.49808
8	203.2004	2.438405	3.62874	30.28352
9	228.6005	2.743205	4.08233	34.06896

Metric Measures into English.

Metric.	Meters to Inches.	Meters to Feet.	Kilos to Pounds.	Liters to Gallons.
1	39.3700	3.28083	2.20462	.26417
2	78.7400	6.56167	4.40924	.52834
3	118.1100	9.84250	6.61386	.79251
4	157.4800	13.12333	8.81849	1.05668
5	196.8500	16.40417	11.02311	1.32085
6	236.2200	19.68500	13.22773	1.58502
7	275.5900	22.96583	15 43235	1.84919
8	314.9600	26.24667	17.63697	2.11336
9	354.3300	29.52750	19.84159	2.37753

Use of the Conversion Tables.

Example: Change 243.6 feet into meters.

$$243.6 = 200 + 40 + 3 + .6.$$

These parts separately may all be directly converted from the table by an appropriate use of the decimal point. Thus, keeping simply three places of decimals:

200	feet =	60.960 meters.
40	feet =	12.192 meters.
3	feet =	.914 meters.
.6	feet =	.183 meters.
Hence, adding: 243.6	feet =	74.249 meters.

Other examples may be solved in an entirely similar manner.

[10] **Reduction of Compound Numbers.**

Example—(1) Reduce 7 miles, 12 rods, 10 feet to feet. We may proceed in two ways: (a) We may reduce the rods to feet and add in the 10 thus: $12 \times 16\frac{1}{2} + 10 = 198 + 10 = 208$. Then reduce the miles to feet and add in the 208 thus: $7 \times 5{,}280 + 208 = 36{,}960 + 208 = 37{,}168$ feet; or (b) We may reduce the miles to rods and add in the 12 thus: $7 \times 320 + 12 = 2{,}240 + 12 = 2{,}252$. Then reduce the rods to feet and add in the 10 thus: $2{,}252 \times 16\frac{1}{2} + 10 = 37{,}158 + 10 = 37{,}168$ feet. The result will, of course, be the same in either case. The factors for making the reductions may be either taken from the tables of Sec. 4 or readily found by separate computation.

Example—(2) Reduce 37,168 feet to miles, rods and feet.

This is the inverse of the above and may likewise be solved in two ways: (a) We may reduce the feet to miles with feet as a remainder, thus: $37{,}168 \div 5{,}280 = 7$ miles and 208 feet remainder. Then reduce the feet to rods with feet again as a remainder, thus: $208 \div 16\frac{1}{2} = 12$ rods and 10 feet remainder. Hence, 37,168 feet = 7 miles, 12 rods, 10 feet; or (b) We may reduce the feet to rods with feet as a remainder, thus: $37{,}168 \div 16\frac{1}{2} = 2{,}252$ rods and 10 feet remainder. Then reduce the rods to miles with rods as a remainder, thus: $2{,}252 \div 320 = 7$ miles and 12 rods remainder. We have, therefore, as before, 37,168 feet = 7 miles, 12 rods, 10 feet.

These examples will sufficiently illustrate the mode of procedure so that all similar problems may be readily solved.

Addition, Subtraction, Multiplication and Division of Compound Numbers.

[11] Addition of Compound Numbers.

Example—Add the following:

16 miles	43 rods	12 feet
21 miles	308 rods	9 feet
7 miles	318 rods	$7\frac{1}{2}$ feet
44 miles	669 rods	$28\frac{1}{2}$ feet
or 46 miles	30 rods	12 feet

The columns are added as in whole numbers and the sums are brought down. This gives a correct result, but it is not in its simplest form, since $28\frac{1}{2}$ feet are more than 1 rod, and 669 rods are more than 1 mile. We therefore reduce the feet to rods, giving 1 rod and 12 feet, and then carry the 1 to the column of rods, giving 670. We then reduce the rods to miles, giving 2 miles and 30 rods, and carry the 2 to the column of miles, thus giving the final result as stated in the second line of the answer.

[12] Subtraction of Compound Numbers.

Example—In the following subtract the lower from the upper:

36 miles	18 rods	14 feet
21 miles	43 rods	6 feet
14 miles	295 rods	8 feet

In the column of rods, the 43 being greater than the 18, we cannot subtract directly, and therefore borrow 1 mile or 320 rods from the 36 miles, thus putting the minuend into the form as follows:

35 miles	338 rods	14 feet
21 miles	43 rods	6 feet
14 miles	295 rods	8 feet

We may then subtract each column as in whole num-

bers, thus giving the result as shown. In the actual operation the borrowing may be done mentally, thus making it unnecessary to rewrite the minuend as shown.

[13] Multiplication of Compound Numbers.

Example—Mutiply 14 miles, 276 rods, 12 feet by 5.

Operation:

14 miles	276 rods	12 feet
		5 feet
70 miles	1,380 rods	60 feet
74 miles	103 rods	10½ feet

We first multiply each term by the multiplier 5 and obtain the result entered in the first line below. This is correct, but not in its simplest form, since 60 feet are more than 1 rod and 1,380 rods more than 1 mile. We therefore reduce the feet to rods, giving 3 rods and 10½ feet, and carry the 3 to the column of rods, giving 1,383. We then reduce the rods to miles, giving 4 miles and 103 rods and carry the 4 to the column of miles, giving the final result as stated in the second line of the answer.

[14] Division of Compound Numbers.

Example—Divide 142 miles, 296 rods, 15 feet by 6.

Operation:

6)142 miles	296 rods	15 feet
23⅔ miles	49⅓ rods	2½ feet

We first divide each term separately by the divisor 6 and obtain the result as written below the line. This is correct, but not in its simplest form, since ⅔ miles may be reduced to rods and feet, and ⅓ rod may be reduced to feet. We therefore simplify as follows:

23	49	2½
	213	11
23	262	13½

Since there are 320 rods in 1 mile, we have ⅔ miles = ⅔ × 320 rods = 213⅓ rods. We set down the 213 in the column of rods, and, adding the ⅓ to the other ⅓ belonging with the 49, we have ⅔ rod in addition. Since there are 16½ feet in 1 rod, we have ⅔ rod = ⅔ × 16½ = 11 feet. This we enter in the column of feet and add, giving the final result as shown.

These examples will sufficiently illustrate the principles involved in the addition, subtraction, multiplication and division of compound numbers so that all similar problems may be readily solved.

Addition, Subtraction and Multiplication of Duo-decimals.

[5] Duodecimals. It is often necessary to determine areas or volumes, the dimensions of which are given in feet and inches. To this end we may either reduce the dimensions to feet and decimals, or treat them directly by the method of *duo-decimals*. In this system of expressing numbers, use is made of a series of numerical units, each one-twelfth of the unit of next higher order. The fundamental unit will be either the linear foot, the square foot or the cubic foot, according to the geometrical nature of the quantity to be expressed. Lengths are thus expressed in feet, inches and twelfths; or, as they are termed, feet, primes and seconds. Similarly areas are expressed in square feet, primes and seconds, and volumes in cubic feet, primes and seconds, the prime in each case being one-twelfth the foot, and the second one-twelfth the prime.

Duo-decimals should be written with a series of accents thus: 6° — 7′ — 10″. The ° stands for the fundamental unit, the foot; which may be a length, an area or a volume, according to the problem; the single accent ′ stands for the prime, and the double accent ″ for the second.[4] Thus, if the unit were a foot of length, the above expression would mean 6 feet, 7 primes or inches, and 10 seconds or $\frac{10}{12}$ inch. If the unit were a square foot it would mean 6 square feet, $\frac{7}{12}$ of a square foot and $\frac{10}{12}$ of $\frac{1}{12}$, or $\frac{10}{144}$ of a square foot. Hence, in all, 6 square feet and 94 square inches. If the unit were a cubic foot it would mean 6 cubic feet, $\frac{7}{12}$ of a cubic foot and $\frac{10}{12}$ of $\frac{1}{12}$, or $\frac{10}{144}$ of a cubic foot Hence, in all, 6 cubic feet and 1,128 cubic inches.

[4] Care must be taken to avoid confusion between this method of writing duo-decimals and the common method of expressing feet and inches by one and two accents.

Addition of Duo-decimals. The addition of duo-decimals is carried on exactly as in compound numbers, quantities of the same order being written under each other and their sums, where necessary, reduced to units of higher order by division by 12.

Example—Add

17° — 8′ — 10″	
14° — 2′ — 9″	
7° — 1′ — 7″	
Sum: 39° — 1′ — 2″	

Subtraction of Duo-decimals. The subtraction of duo-decimals is carried on exactly as in compound numbers, quantities of the same order being written under each other and units of a higher order being borrowed where necessary.

Multiplication of Duo-decimals. This operation, which is the one of greatest importance in the treatment of duo-decimals, is carried on according to the following:

Rule—Set down the two quantities, with terms of the same order under each other. Multiply each term of the multiplicand by each term of the multiplier. The order of any such product will be determined by adding the indices of the two terms used. If the product is greater than 12, reduce to the next higher order by dividing by 12, and set down the quotient and remainder in their proper columns. Proceed in this way, taking care in the product to set down terms of the same order under each other. Then add and reduce where necessary to the higher order by dividing by 12.

Example—Multiply together:

6° — 10′ — 4″			‴
4° — 8′			
4	6	2	8
3	1	8	
24	4	4	
31°	11′	2″	8‴

We have first 8′ × 4″ = 32‴ = 2″ — 8‴, which is set down. We have next 8′ × 10′ = 80″ = 6′ — 8″, which is set down. We have next 8′ × 6° = 48′ = 4°, which is set down. In the same way we use the other term of the multiplier, 4°, and then add and reduce the columns as shown.

For purposes with which the marine engineer is concerned, feet and inches are alone involved, and operations with duo-decimals are correspondingly simplified.

Examples—(1) Find the area of a boiler plate 12° — 5′ long by 6° — 7′ wide.

Multiplying as before, we find for the product 81° — 8′ — 11″, or taking the result to the nearest prime, 81° — 9′ or 81$\frac{9}{12}$ square feet or 81 square feet — 108 square inches.

(2) Find the volume of a bunker 26° — 4′ by 9° — 7′ by 7° — 10′.

Taking first the product of 26° — 4′ by 9° — 7′, we have 252° — 4′ — 4″. Then multiplying this by 7° — 10′ we have 1,976° — 10′ — 11″ — 4‴, or taking the result to the nearest prime, 1,976° — 11′, or 1,976$\frac{11}{12}$ cubic feet or 1,976 cubic feet — 1,584 cubic inches.

§ 6. RATIO AND PROPORTION.

The ratio between two numbers is simply their numerical relationship expressed as the quotient of the first divided by the second. Thus the ratio of 6 to 3 is 2; of 1.2 to 3 is .4; of 4 to 5 is .8, etc. Ratio is often expressed by the sign : which is simply an abbreviation of the sign of division ÷. Thus 6 : 3 = 2; 1.2 : 3 = .4, etc. Ratio is also expressed by the sign of division or in the form of a fraction. Thus

6 : 3 or 6 ÷ 3 or $\frac{6}{3}$ = 2
1.2 : 3 or 1.2 ÷ 3 or $\frac{1.2}{3}$ = .4, etc.

Simple Proportion.

[1] A *proportion* is a statement of the equality of two ratios. The equality is commonly expressed by the symbol : :

Thus. $6 : 3 : : 4 : 2$.....(1)

A proportion may also be written in other ways, as follows:

$6 : 3 = 4 . 2$.....(2)

$\frac{6}{3} = \frac{4}{2}$ .....(3)

A proportion always contains four terms, two for each ratio, and when written as in (1) and (2) the first and last terms are called *extremes* and the second and third are called *means*. To solve a proportion three terms must always be known and then the remaining term can always be found. From the nature of a proportion it follows that the product of the extremes must equal the product of the means, and this gives the usual rule for solution as follows:

Rule—If the unknown term is an extreme, multiply together the two means and divide by the other extreme. If the unknown term is a mean, multiply together the two extremes and divide by the other mean. In either case the quotient will give the remaining term desired.

In a proportion two of the terms always relate to one kind of quantity, while the other two relate to another. Likewise two of the terms always relate to one set of conditions, while the other two relate to another set. In problems to be solved by proportion, therefore, where three terms must be given, two terms will be of one kind and the remaining term will be of another and of the same kind as the answer. Also two terms will relate to the given set of conditions, and the remaining term to the set involving the unknown term or answer.

Again, proportions are of two kinds, *direct* and *inverse*. In a direct proportion the relation between the two quantities different in kind is such that both increase or decrease together. In an inverse proportion the relation between these two quantities is such that one increases as the other decreases. Thus if the question involves the relation between distance and speed, the time being the same, the proportion is direct, because, for a given time, the more speed the more distance, or the more distance the more speed. On the other hand, if the question involves the relation between speed and time for a given distance, the proportion is inverse, because, for a given distance, the more speed the less time, or the more time the less speed, and *vice versa*. Our general knowledge of the relation between the quantities involved will thus enable us to determine whether the proportion will be direct or inverse.

Example of a direct proportion:

If a ship steams 1,400 miles in 5 days, how far will she steam in 8 days at the same rate?

Here two of the given terms are days and one is miles, being of the same character as the answer desired. Also two relate to one performance or set of conditions (1,400 miles in 5 days) while the other relates to another set (the desired performance in 8 days). Our right to solve this example by direct proportion lies in the fact that the relation between the 5 days and 1,400 miles must be the same as that between the 8 days and the distance desired, and hence there must be an equality in the ratios showing these relations, and similarly for problems of like character.

A simple *direct* proportion, like that involved in the example above, may be stated in various ways, of which two will serve our present purpose.

(a) $\overset{(2)}{\text{Ans. (miles)}} : \overset{(2)}{8\text{ (days)}} : : \overset{(1)}{1400\text{ (miles)}} : \overset{(1)}{5\text{ (days)}}$

(b) $\overset{(2)}{\text{Ans. (miles)}} : \overset{(1)}{1400\text{ (miles)}} : : \overset{(2)}{8\text{ (days)}} : \overset{(1)}{5\text{ (days)}}$

The numbers in ( ) relate to the two sets of conditions, the first being the set given, and the second being the set for which the distance is desired. It is thus seen that the proportion may be stated as in (a), with each set of conditions forming a ratio, the items of the proportion alternating: miles, days, miles, days: or it may be stated as in (b), with the set of conditions alternating 2d, 1st, 2d, 1st, the two items of each ratio being the same.

Example of an inverse proportion:

If a ship at 10 knots does a certain trip in 5 days, how many days will be required at 12 knots?

The relation between time and speed, as we know, is such that, for a given distance, the more speed the less time, or the less speed the more time. The time is, therefore, said to be in such case *inversely* proportional to the speed. That is, for example, if the speed is *doubled* the time will be *halved*, etc.

An inverse proportion may be stated as follows:

(c) $\overset{(2)}{\text{Ans. (days)}} : \overset{(1)}{10\text{ (knots)}} : : \overset{(1)}{5\text{ (days)}} : \overset{(2)}{12\text{ (knots)}}$

(d) $\overset{(2)}{\text{Ans. (days)}} : \overset{(1)}{5\text{ (days)}} : : \overset{(1)}{10\text{ (knots)}} : \overset{(2)}{12\text{ (knots)}}$

The difference between these methods of statement and those above for direct proportion will be readily seen by comparison.

As another general way of stating a proportion whether direct or inverse we may proceed as follows:

Put the *answer*, or letter representing it, for the first term, and the other quantity of the same kind for the second term. Then, according as the first term or answer should be greater or less than the second term, write the third and fourth terms in the same order. That is if the relation of the quantities is such that the *answer* should be greater than the second term, write the third and fourth terms in the order *greater — lesser:* or if the *answer* should be less than the second term, write the third and fourth terms in the order *lesser — greater.*

After having become familiar with the methods of stating a proportion, the names of the quantities and the numbers denoting the sets of conditions may, of course, be omitted, and we should have instead of (a) and (b)

$\text{Ans.} : 8 : : 1400 : 5$

$\text{Ans.} : 1400 : : 8 : 5$

Solving either of these according to the rule given, we have:

$$\text{Distance} = 8 \times 1400 \div 5 = 2240 \text{ ans.}$$

Likewise instead of (c) and (d) we should have:

$\text{Ans.} : 10 : : 5 : 12$

$\text{Ans.} : 5 : : 10 : 12$

Solving either of these we have:

$$\text{Days} = 5 \times 10 \div 12 = 50 \div 12 = 4\tfrac{1}{6} \text{ Ans.}$$

OBITUARY.

John H. Dialogue, the shipbuilder, of Camden, N. J., died at his residence, Sunday, October 23, after several weeks' illness.

John Murray Forbes died at his residence in Milton, Mass., October 11, at the advanced age of 85 years. For many years he had engaged in the shipping business, although more recently he had given much attention to railroad investments. At various times he was the owner of both steam and sail yachts.

Chief Engineer Philip Inch, U.S.N., who was retired last August, died suddenly at Dr. Strong's sanitarium, Saratoga, October 19, from neuralgia of the heart. Mr. Inch was 62 years old. He was appointed to the Navy from the District of Columbia in 1857, and entered the service as third assistant engineer of the frigate Roanoke. In 1863 he was promoted to chief engineer. From 1881 to 1884 he was fleet engineer of the Asiatic station. He was with the Bureau of Steam Engineering in 1884-5, and was also a member of the Board of Inspection.

THE ART OF MAKING MECHANICAL SKETCHES —FOR MARINE ENGINEERS.—V.

BY PROF. C. W. MAC CORD.

In the preceding article, it will be recollected, were explained the processes by which, from the drawings of an object in its most simple position in relation to the paper, we are enabled to construct the correct representation of the same object in the most complicated position in which it can be placed. For the sake of simplicity and uniformity, the rectangular prism was selected as the object; and it was shown that the projections of its upper and lower bases would in all cases be either rectangular, or parallelograms with acute and obtuse angles. But the original bases being rectangles, a circle could always be circumscribed about either, hence the corners of the bases would be points in those circles; and it was pointed out that by doubling the numbers of the sides of the bases, any desired number of points in the circumscribing circles might be found in any one of the projections, and the projections of the circle thus obtained.

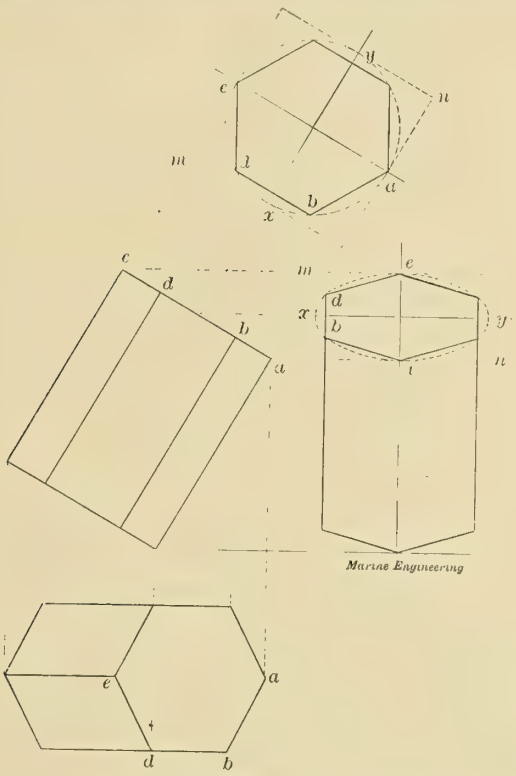


Fig. 22.

Now if the base of the prism be any regular polygon whatever, it can also be circumscribed by a circle, and the angles of the polygon will in like manner be points in the circumference, in whatever position the object be placed. In Fig. 22 are shown three views of a hexagonal prism, inclined to the right, the true form and size of its base being shown in the direct top view above. The corresponding points in the different views being similarly lettered, the construction requires no explanation. Since the circle in the direct end view passes through the points *a*, *b*, *d*, etc., it must in the side view also be represented by a curve passing through those points. By doubling the number of sides of the polygon, we could determine twice as many points in the curve, and so on as far as one chose to carry the process of subdivision.

This, obviously, amounts to nothing more than finding the projections in the right-hand view of so many points in the direct end view; and if our object be to represent the circle, it would make no difference whether those points should be actually equidistant or not. We might then take any points at pleasure in the original circle, and by the principles already explained determine their projections in any position of the cylinder which circumscribes the prism. And if the operations be accurately performed, the result would be correct, whether the operator knew what the resulting curve should be, or not.

This, however, would involve considerable work, even when, as in this case, but one of the three

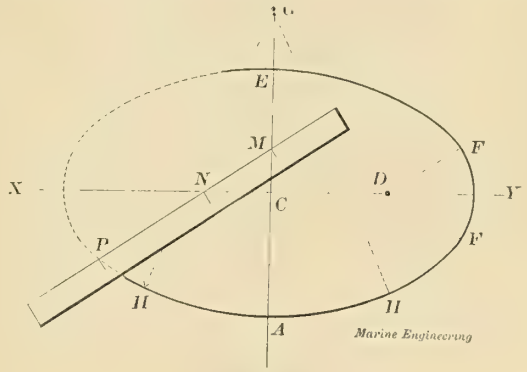


Fig. 23.

rotations has been performed; and it is clear that if the other two be superadded, this method would be exceedingly tedious.

A much more expeditious method is to make use of a circumscribing figure instead of an inscribed one. Thus, drawing the square *m n* in the direct top view, this will appear in the right-hand view as the rectangle *m n*, of which two sides are equal and parallel to *a e*, the other two to *x y*; and the sides of the original square being tangent to the circle, the sides of the square will be tangent to the curve, which is of itself an advantage, as indicating the direction of the curve at the points of contact.

Now, we may avail ourselves of the fact that any inclined projection of a circle is an ellipse, and having the major axis *x y* and the minor axis *a e*, we can proceed to draw the curve without finding the projections of any more points. And the ellipse is

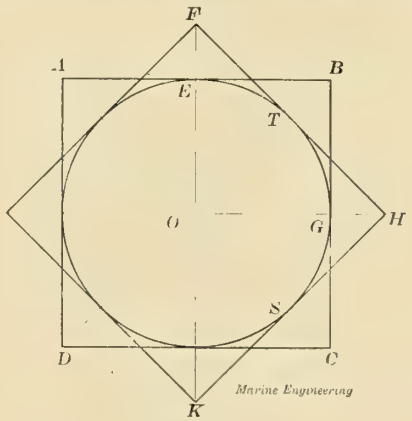


Fig. 24.

so frequently met with in mechanical drawing, not only in the representation of inclined cylinders, but in constructing the sections of both cones and cylinders by inclined planes, that we introduce here, for the benefit of any who may not be familiar with them, one or two ready methods of laying out this curve.

When the axes are given, as *X Y*, *A E*, in Fig. 23; on

the straight edge of a slip of paper set off $P\ M$ equal to the semi-major axis $C\ Y$, and $P\ N$ equal to the semi-minor axis $C\ A$. Then move the slip around, keeping the point M always on the line of the minor axis, and N always on the line of the major axis; the point P will then always lie upon the ellipse.

In drawing the curve, a center G upon $A\ E$ produced, can be found by trial and error, from which a circular arc as $H\ A\ H$ can be drawn, which will sensibly coincide with that part of the ellipse. In like manner a center D upon the other axis is found,

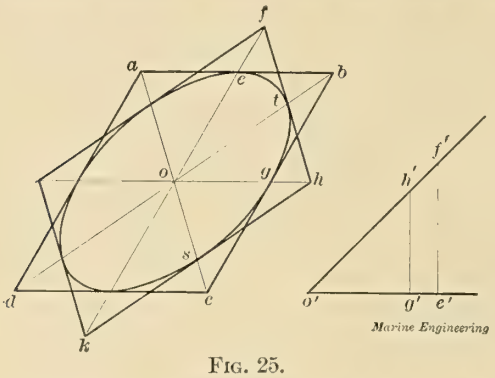


FIG. 25.

with which the approximating arc $F\ Y\ F$ is drawn, thus leaving but a short portion to be finished by the aid of the curved rulers.

But it may be required to draw the cylinder after more than one rotation has been performed, in which case the square circumscribing its base will no longer be a rectangle. It will, however, be a parallelogram, no matter what may be the original position of the square.

A simple process may be used in this case, the first step in which is to suppose the circle to be circumscribed by two squares, $A\ C$, $F\ K$, as in Fig. 24, the sides of each being parallel to the diagonal of the other. In the required position, each of these squares will be represented by a parallelogram, as shown in Fig. 25, and the sides of each will still be parallel to the diagonals of the other, as in the case of the original squares.

Moreover, the points T, G, S, etc., in which the side of either square cuts the diagonal of the other,

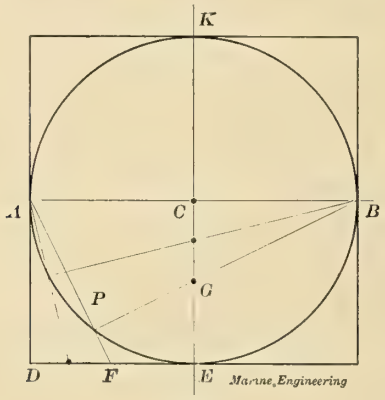


FIG. 26.

are points of tangency; so that if the projections of these squares, as $a\ c$, $f\ k$, be determined, and the diagonals drawn, we shall have eight points in the ellipse as e, t, g, s, etc., and what is of more importance, the tangents at those points, which would enable us to sketch in the curve with a fair approach to accuracy.

It seems hardly possible to attain our result with less trouble than is involved in finding the projection, as $a\ c$, of one of the supposed squares, $A\ C$. But, once that is done, it is not necessary to draw the other square $F\ K$, nor to determine the projection of its corresponding parallelogram $f\ k$.

Because $O\ G$, $O\ H$, being equally foreshortened, would be represented by $o\ g$, $o\ h$, having the same ratio, which is that of the side of a square to its diagonal. Supposing now the parallelogram $a\ c$ to have been determined (as the projection of the square $A\ C$ of Fig. 24), thus determining $o\ g$; then in the small auxiliary diagram draw $o'\ x$ and $o'\ y$, making with each other an angle of 45°; from o' set off on $o'\ x$, a distance $o'\ g'$ equal to $o\ g$, and at g' draw a perpendicular to $o'\ x$, cutting $o'\ y$ in h'; also we may make $o'\ e' = o\ e$, and erect a perpendicular to determine $o'\ f'$. Then setting off $o\ h$, $o\ f$, respectively equal to $o'\ h'$, $o'\ f'$, we may complete the projection of the second square without drawing the original.

Thus we still have eight points in the required curve, and also, as before, the tangents at those points; and the guidance thus furnished is sufficient to enable one, with very little practice, to sketch in the curve with considerable precision.

But if the drawing be on a large scale, the need of other points may be felt; but we have not now the axes of the ellipse, nor is there any ready means of determining them without first drawing the curve itself, so that the method of the paper trammel cannot be applied.

In this case, resort may be had to another process, the principle of which will be clear by the aid

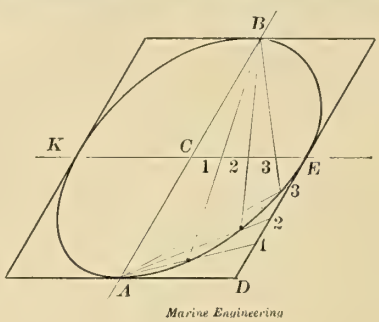


FIG. 27.

of Fig. 26. Having given the circle with its circumscribing square; from one extremity A of a diameter, draw a line through any point P on the circumference, produce it to cut the side of the square in F, and join $P\ B$, cutting $C\ E$, in G, then $B\ C$ is perpendicular to $A\ D$, $C\ G$ to $D\ F$, and $B\ G$ to $A\ F$, therefore the triangles $B\ G\ C$, $A\ F\ D$, are similar, and $D\ F$: $A\ D$: : $C\ G$: $C\ B$. Or, since $A\ D = D\ E$, and $C\ B = C\ E$, we have $D\ F : D\ E$: : $C\ G : C\ E$. Had we reversed the process, for instance bisecting $D\ E$ at F, and $C\ E$ at G, then drawing $B\ G$ through G and producing it to cut $A\ F$, it follows that the point of intersection P must lie on the circumference; by bisecting $D\ F$ and $C\ G$, another point on the circumference could be found in a similar manner, and such a subdivision may be carried as far as we choose.

Now when this square is projected in an oblique position, all the subdivisions on $C\ E$ will be foreshortened in the same proportion; and so will those on $D\ E$, though those two proportions may not be the same.

Supposing then that this square is finally projected as the parallelogram in Fig. 27; divide $C\ E$ into any number of equal parts, and $D\ E$ into the same number; from A draw lines to the points of division, 1, 2, 3, on $D\ E$, and from B draw lines through the points 1, 2, 3, on $C\ E$, producing them to cut the first series, in their order; then the points of intersection will lie upon the ellipse, which is the foreshortened representation of the original circle.

ENGINEERS' DICTIONARY—XI.

Connecting-Rod.—That part of an engine which connects at one end with the crosshead and at the other with the crank. One end thus moves in a vertical straight line path, while the other travels in a circle. It is thus the member which directly effects the transformation of the straight-line motion of the piston and crosshead into the circular motion of the crank. Marine connecting rods differ chiefly in the

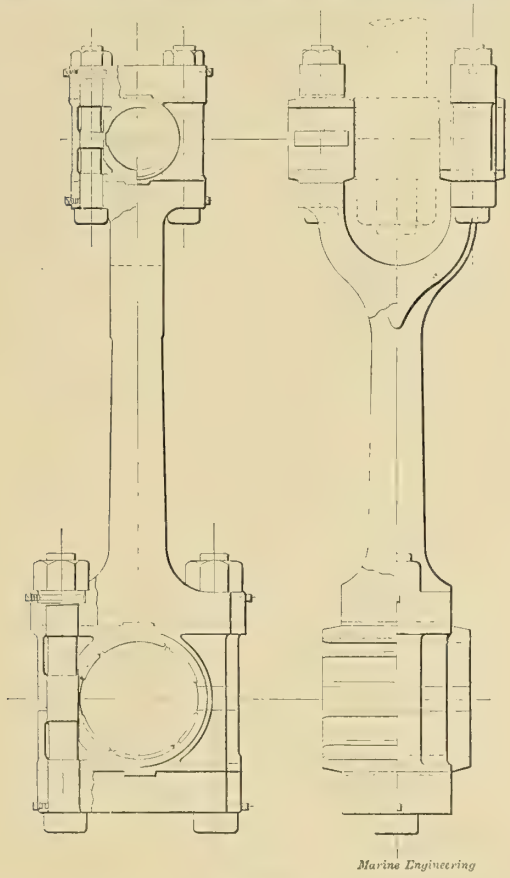


FIG. 35.

mode of attachment to the crosshead. In one of the two ordinary types, as shown in Fig. 34, the pin is secured fast in the upper forked end of the rod, its bearing being provided in the crosshead. With the other type shown in Fig. 35 the pins are two in number and are fast in the crosshead or forged with it, their bearings being provided in the upper forked ends of the connecting rod.

Consumption of Steam.—A term used to denote the number of pounds of steam required to develop one indicated horse power for a period of one hour. With good triple-expansion marine engines the figure is usually not far from 15. With lower pressure and with compound engines it will rise to 17 or 18, with simple condensing engines to 25 or 30, and with simple non-condensing to 30 or 40 or more. It should not be forgotten that the steam engine is really a *heat* engine, and hence the number of pounds of steam required is not an exact measure of the economy of the engine, since the formation of one pound of steam may require more or less heat depending on its pressure, temperature of the feed, and quality of the steam. The steam consumption answers, however, for purposes of approximate estimate, and is much used in the absence of more definite information relating to the actual amount of heat required.

Corrugated Furnace.—A form of boiler furnace in which the metal is disposed in corrugations as shown in Fig. 36. It is known that the strength of a cylindrical shell exposed to pressure on the outer or convex side depends on the length and is less as the length is greater. It may be considered that the corrugations of a furnace are equivalent to its subdivision into a large number of short lengths represented by the hollows, each supported by the convex intermediate ridges. This results in a shortening of the length as related to strength, and hence in an in-

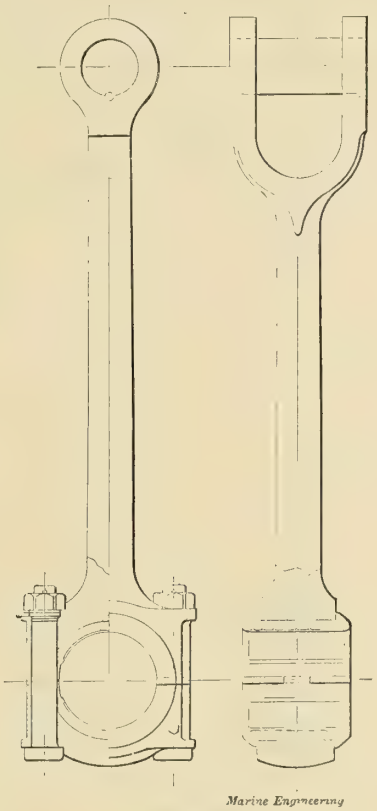


FIG. 34.

crease of strength for a given thickness of metal. The corrugated furnace has also much greater longitudinal elasticity than the plain form, and is thus the better able to withstand expansion and contraction caused by extreme changes of temperature. There are various styles of corrugation, those most com-

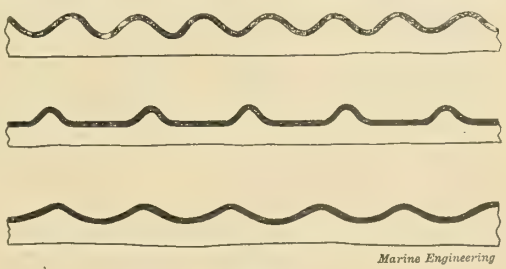


FIG. 36.

monly used being the "Fox," "Morison" and "Purves," as shown in Fig. 36, in the order named, commencing at the top. Corrugated furnaces of one type or another are used almost entirely in present engineering practice.

Counter.—An apparatus used to mechanically register the revolutions of the engine.

Counter-bore.—A space at the end of a cylinder of diameter slightly greater than the bore, and so placed that the piston shall slightly overrun its edge, and thus in case of wear avoid the formation of a shoulder.

Counter-sunk bolt or rivet.—A bolt or rivet in which the head is conical in form and is let in to the

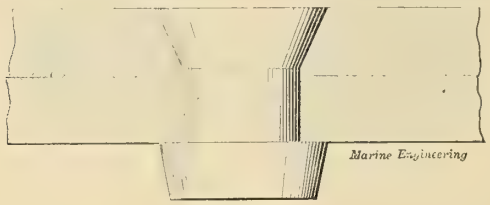


Fig. 37.

part to be held in such way that there is little or no projection beyond the surface. See Fig. 37.

Coupling.—In general, a means of connecting two moving members of a machine. In particular, the means used to connect the successive lengths of shafting. This consists usually of a pair of flanges connected by bolts, as shown in Fig. 38. Another style of coupling is used for connecting shafts by a sleeve without the use of any enlargement at the end of either part. Such couplings are sometimes used to couple the length of shaft, which passes outboard through the ship's skin, to the length next forward. Couplings of this type are also carried for

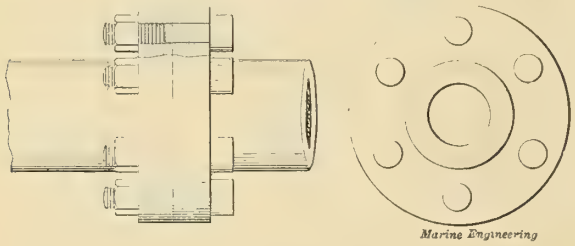


Fig. 38.

emergency purposes in case of a broken shaft. Between the crank-shaft and line-shaft a special style of coupling is sometimes provided of such form as to serve the purpose of a universal joint. This provides a flexible coupling between the two lengths of shafting and thus allows a slight difference in alignment between them.

Coupling Flange.—The flange of a shaft coupling.

Cross-Head.—The part of a steam engine which serves to join the connecting rod with the piston. The typical modern marine cross-head as shown in Fig. 39 comprises an approximately cubical body, through which passes the piston-rod secured by a nut

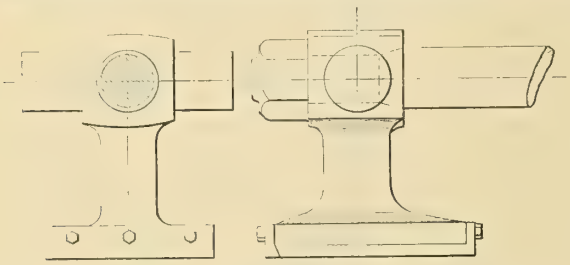


Fig. 39.

on the lower side. On either side fore and aft are attached the cross-head pins which connect with the forked extremity of the connecting-rod. On one or both sides laterally are attached the slide surfaces which bear on the guides, supported in turn by the columns. In the so-called *slipper* cross-head as shown in the cut there is but one slide or *slipper*. In such case with go-ahead motion the outer surface of the slipper bears on the surface of the guide, which thus receives and supports the transverse force due to the obliquity of the connecting-rod. For backing motion the corresponding force is taken on the inner faces of the slipper, which bear on cheek pieces attached to the column. Referring to *connecting-rod*, it will be seen that the form of cross-head in Fig. 39 corresponds to that form of connecting-rod which carries the bearings for the cross-head pins. For the other type of connecting-rod the cross-head must provide a bearing for the pin which in turn is rigidly attached to the rod as described under that heading. In such case, Fig. 40, the lower end of the piston-rod is forged out so as to form the support for this bearing so that a part of the cross-head and the piston-rod are of one and the same forging. The arrangement of guide surfaces may be the same in either type of cross-head.

Crow-foot.—A form of boiler brace in which the end is spread out into two or more points of attachment to the shell. Forms of the brace in which the points of attachment are more than two are now nearly obsolete.

Crown or Crown-sheet (of combustion chamber or furnace).—The highest plate in a combustion chamber or furnace, and hence the place most likely to be uncovered in case of low water.

Crown-bar.—A form of brace used for supporting the flat top of a combustion chamber. This is shown

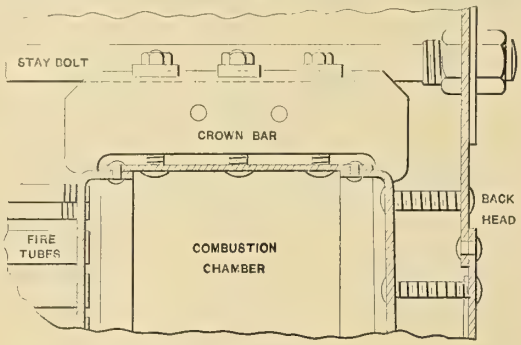


Fig. 41.

in position in Fig. 41, which represents the top of the combustion chamber of a Scotch boiler and neighboring portions of the boiler. See *Boiler.*

Cushion.—*Compression.*

Cut-off (to).—As a verb the word denotes the act of closing a slide valve used to admit steam to a cylinder. This operation is effected before the end of the stroke in order to cause the steam to work expansively for the remainder of the stroke. As a noun the word refers to the act of closing a steam valve, or to

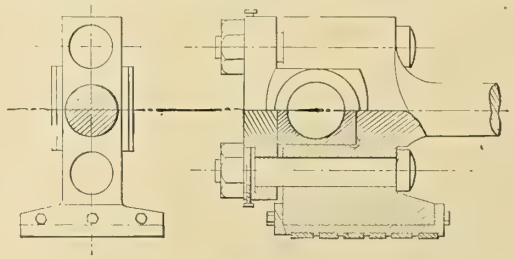


Fig. 40.

the point in the stroke or on the indicator card at which it is effected.

Cylinder.—In general any body of cylindrical form. More particularly a part of an engine or pump containing a movable piston and a gas, vapor or liquid under pressure. The cylinder of a steam engine re-

ceives the steam from the steam-chest alternately in each end and enables it to act on the piston, thereby producing the movement of the latter and through it the motion of the connecting-rod, crank and shaft. The cylinders of marine engines, see Fig. 42, are of cast-iron and consist essentially of a cylindrical body or barrel with which is usually cast the *lower* or *bottom head*. With the cylinder are usually cast also the valve casings or chests and all ports and passages, as well as the necessary feet for attachment to the columns, lugs for attaching braces, etc. The *top head* or *cover* is cast separately and is secured to an appropriate flange on the barrel by means of stud bolts. In many cases working liners are fitted within the barrel

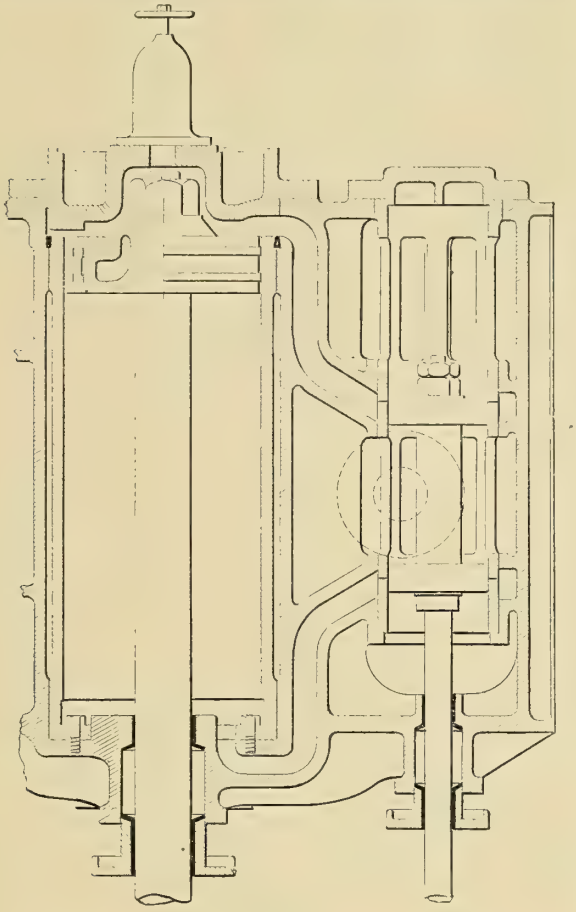


FIG. 42.

or cylinder proper. These are of extra hard and fine grained iron, and are fitted especially to provide a wearing surface and to admit of replacement in case of excessive wear. If the cylinders are to have steam jackets, liners must be fitted, the space between the barrel and liner providing the jacket space required. Cylinders as well as jackets are usually provided with *drain cocks* or *valves* with suitable piping so that water collecting within them may be drained away. In addition, *automatic relief cocks* or *valves* should be fitted, capable of opening under appropriate pressure, and thus furnishing relief in case a large quantity of water may find its way into the cylinder. The cylinders are supported on the columns and for mutual support are quite commonly tied together by braces, or flanged and bolted to each other. Fig. 42 shows the high pressure cylinder of a triple-expansion marine engine, with the valve chest and piston valve.

T. H. Chappell, of New London, has been credited with the purchase of the Old Field Shipyard, at West Mystic, Conn.

QUERIES AND ANSWERS.

If our western correspondent who signs himself "Engineer" will send his correct name and address, his query regarding indicator cards will receive attention, otherwise not. EDITOR M. E.

Q.—Will you please tell me in your next issue what is meant by the clearance of an engine?

SUBSCRIBER.

A.—You will find an explanation in the *Engineers' Dictionary* in Marine Engineering for September, page 39.

Q. What is the proper ratio between the area of steam and exhaust pipes? R. S.

A.—Where there are no structural limitations as to the size of pipes and passages, a very common rule is to make the exhaust passage 50 per cent larger, or one and one-half times the size of the steam passage. Due to limitations, however, it is often necessary to accept a smaller increase for the exhaust, as, for example, 30 per cent or 40 per cent over the size of the steam pipe and passage. The reason for an increase in size is that the exhaust may be as free and unobstructed as possible, and that the back pressure in the cylinder may be reduced to its lowest limits.

Q.—If the water cylinder of a pump is 6 in. in diameter, what is a suitable size for the steam end?

TOLEDO.

A.—Assuming that the pump were intended for boiler feed, or for fire and general service, the common diameter for the steam end would be about 10 in. The steam end is thus made larger than the water end in order that the total pressure on the steam side may be much greater than the resistance on the water side, and thus enable the pump to overcome the resistance of valves, pipes and bends, and to force the water back into the same boiler from which the steam is drawn, or against the same or even a greater pressure per square inch than that which acts on the steam side.

If, on the other hand, the pump were for light service, such as forcing water through a surface condenser or lifting water from the bilge and discharging it overboard, so great a total force on the steam side is not required, and the diameter of the steam cylinder would be about the same as that of the water cylinder, or in some cases even slightly less.

Q.—With the following data please work out the distance apart from center to center of stay bolts. $S = \frac{2H2C}{P}$. P = pressure per sq. in. = 150. S = distance between stays. C = constant, say 54,000, H = thickness of plate = 7-16"; let factor of safety 6 when C = 9,000? TEXAS.

A.—The rule you refer to in your letter does not agree with the one given in the United States rules. The latter will be found on p. 20 of the "General Rules and Regulations Prescribed by the Board of Supervising Inspectors of Steam Vessels," issue of 1896, and is as follows:

"When plates 7-16 inch thick and under are used in the construction of marine boilers, using 112 as a constant, multiply this by the square of the thickness of the plate in sixteenths of an inch. Divide this product by the square of the pitch or distance from center to center of stay bolt."

"Plates above 7-16 inch thick, the pressure will be determined by the same rule, excepting the constant will be 120."

Using the rule with your data we should have:

$$150 = \frac{112 \times 49}{\text{Square of pitch.}}$$

From this we find:

$$\text{Square of pitch} = \frac{112 \times 49}{150} = 36.6$$

Hence pitch = 6 in. nearly.

Screw stay bolts are rarely fitted with so close a spacing as 6 in., and a 1-2 in. plate and 7 in. spacing, for which the allowed pressure is 156 lbs., may be recommended as a preferable arrangement.

Q.—What is the formulae to find the amount of power required to drive a vessel at a given speed?

J. G. McC.

A.—No formula for the powering of ships has ever been devised which will admit of use except as the user is guided by experience, either his own or that of others. On the other hand many formulae have been devised in order to make possible the use of such experience in the solution of this problem. One of the simplest and perhaps of the widest use is the so-called *Admiralty Displacement* formula or *Admiralty Coefficient* formula. This is as follows:

$$H = \frac{D^{2/3} \cdot v^3}{K}$$

In this formula,

H denotes the *I.H.P.* required.

D denotes the displacement in tons.

v denotes the speed in knots.

K denotes the coefficient whose value is to be determined in accordance with the special circumstances of the problem. The displacement D is, of course, proportional to the volume of the immersed body, and the expression $D^{2/3}$ or the square of the cube-root of the displacement represents a surface—the face of a cube, in fact, whose volume in cubic feet would equal the displacement in tons. The other definite factor is v, the speed, which is raised to the 3d power in the formula. To these two quantities the power is related by means of the coefficient K, which depends upon and must take care of all other conditions which may affect the question of power. Such are the *proportions* and *form* of the ship and the relation of the speed to them and to the length, the character of the *surface* of the ship as affecting the skin resistance, the mechanical efficiency of the engine, and the propulsive efficiency of the propeller.

Now the relation of these influences to the power required is only imperfectly known, and we cannot therefore substitute for K mathematical expressions involving them, and thus have an entirely definite formula throughout. We must instead determine a value for K by other means, and there are in general two methods followed in this selection of a suitable value.

The first and older one is to select a value simply by judgment, based on a knowledge of the special circumstances, and guided by experience in a general way. The second and more modern is to assume the extension of the so-called *law of comparison* to the entire resistance of the ship, and then, as authorized by this law, determine the coefficient for any given set of conditions by a comparison with experimental results for other ships of similar form and like conditions, and at speeds related to the desired speed of the given ship in a manner to be explained directly.

With the first method the value is simply selected by judgment and without other than mental comparison between the proposed conditions and others of a generally similar character with which the designer may be familiar. With relatively long fine ships designed for moderate speeds (say not much exceeding in knots 2-3 to 3-4 the square root of the length in feet) and with good machinery and efficient propellers the value of the coefficient may rise to 275 or even to 300 in extremely favorable cases. As the ship becomes more full in form or relatively broader, or as the speed is relatively higher (approaching a speed in knots equal to the square-root of the length in feet), the values are usually found from 260 or 270 downward to 220 or less. As the form becomes relatively still broader and fuller, or as the speed is relatively still higher (reaching values in knots of 1 1-2 to 2 times the square-root of the length in feet), the value of K decreases down to 100 or even less for small boats, not of particularly good form, and driven at extreme speeds. The range of values for good average practice is usually found between 220 and 270.

With the second mode of treatment use is made of the extended law of comparison which, for the present purposes, may be expressed in the following terms.

Similar ships at corresponding speeds have the same Admiralty coefficient.

By *similar* ships is meant ships with similar proportions and characteristics of form, and with generally similar or equally efficient engines and propellers. By *corresponding* speeds is meant speeds at which the two ships will be surrounded with similar wave configurations. This is very closely attained when the ratio of the two speeds equals the square-root of the ratio of the lengths.

When, therefore, a problem is to be solved by this method, search must be made for data relative to a similar ship at a corresponding speed. The value of the coefficient may then be derived by the use of the known data, and the same coefficient then used with the values of D and v for the proposed case will give the corresponding estimate of power as desired. If several estimates are made in this way from different ships, each may be considered as furnishing an approximate value, and the mean may be taken, or such other value as may seem suitable in view of special circumstances.

The latter of the two methods thus outlined is much the more scientific, as it provides a definite mode for the utilization of results derived from previous experience, but there is still need for the exercise of much care and judgment in deciding on how closely the ships must be similar in order to allow of a reasonably safe appreciation of the rule, and as to questions of difference in details of machinery, propellers, conditions of trial, etc.

As an example of the use of this method by comparison, suppose that we have a proposed ship of length 300 ft., displacement 3,000 tons, and speed of 17 knots. A search among the available trial results for generally similar ships furnishes four examples as follows:

(1) L = 250 Disp. = 1900
(2) L = 350 Disp. = 4500
(3) L = 320 Disp. = 3600
(4) L = 220 Disp. = 1200

For (1) the speed v corresponding to 17 knots will be given by the proportion:

$$v : 17 :: \sqrt{250} : \sqrt{300}$$

$$\text{or } v = 17 \sqrt{\frac{250}{300}} = 15.5$$

Turning now to the trial results for this ship we take the power at 15.5 knots, and from these known values of *power, displacement* and *speed*, find the corresponding value of K. This is done by reversing the horse power formula above so as to read:

$$K = \frac{D^{2/3} \cdot v^3}{H}$$

Suppose the value of K thus found to be 220. We then use this value in the power formula with the values of D and v for the *proposed* ship, and find 4,645 as the value of the I.H.P. according to this means of estimate. From ship (2) we derive similarly a coefficient of 230 and a power for the *proposed* ship of 4,443, while from (3) and (4) we similarly derive coefficients of 215 and 225, and powers for the *proposed* ship of 4,753 and 4,541. Taking the mean of these four values we have 4,595, and we may feel a reasonable confidence in such a value, or say 4,600, as the power necessary in the given case, provided the ships are approximately similar, and the conditions under which the trial results were taken were normal and regular in each case.

By the method of determination first described, instead of finding, as above, values of the coefficients 220, 230, etc., it is simply necessary to assume a value of K off hand, as 225, for example, bringing to bear on the choice such general judgment as experience may furnish.

For finding the values of $D^{2/3}$, engineering hand-books often provide special tables giving the two-thirds powers of numbers. If such a table is not at hand, it may be remembered that the quantity desired is the square of the cube-root or the cube-root of the square, and hence the ordinary handbook with tables of squares and square-roots, cubes and cube-roots will provide a means for finding the values desired.

"A Catechism of the Steam Plant," chiefly for the use of stationary engineers, by F. F. Hemenway, has just been issued from the press of "Locomotive Engineering," New York. It is a book suitable for the instruction of engineers who intend to prepare themselves for the better class of positions. The price of the catechism is 50 cents, a thoroughly good investment.

TECHNICAL PUBLICATIONS.

THE INDICATOR HANDBOOK. By C. N. Pickworth, Whitworth Scholar, Part 1, 1898. New York, D. Van Nostrand Co., 23 Murray street. With many illustrations. Size, 5 by 7 1-2. Pages, 130. Cloth, $1.50.

The book treats of the Indicator as an instrument only, leaving the subject of the indicator diagram and its analysis to a second part of the work now in active preparation. At first sight it would seem that the indicator has been pretty thoroughly discussed, but a careful perusal of this work will convince that there is still much to be said which is new and interesting. The first chapter gives detailed description and illustrations of the development of the instrument, showing all the trouble-saving devices of the modern varieties, as well as indicators for hydraulic, ammonia and gas engines. Then follows a very instructive description of errors which are caused by faulty handling of the instrument itself under certain conditions, and errors of attaching it. Although intended for general steam engine work, the subject of reducing gears may be well studied by marine engineers, as there are many devices shown which would be very handy in engine rooms where space is valuable.

JUSTUS PERTHES' DEUTSCHER MARINE-ATLAS (German Navy Atlas). Compiled by Paul Langhaus, with notes by Lieutenant Commander A. D. Bruno Weyer, Imperial German Navy. Justus Perthes, Gotha, Germany, 1898. Size, 8 by 12. Pages of text, 12; maps, 5. Paper covers, 1 mark.

This pamphlet contains a complete list of the ships of the German navy, including those now under course of construction, giving their displacement, speed, power, armament, etc., and their location up to July of this year. A number of carefully drawn colored maps show the positions of coaling stations, navy yards, coast positions open to attack and coast fortifications in Germany, as well as in all the German colonial possessions. A short description of the services performed by the various vessels since 1872 is of interest, also tabulated statements of expenses and appropriations of the navies of different countries and the proportions of the same to the foreign investments of these countries. It also includes a short description of the development of the German merchant marine and a comparison between total tonnage of German and foreign vessels sailing to German ports, also a list of vessels available for auxiliary cruisers. Altogether it is an exeremely valuable work of reference. In points of typographical excellence it is a thoroughly good job.

A HANDBOOK OF ENGINEERING LABORATORY PRACTICE. By Richard Addison Smart, M.E., Purdue University. John Wiley & Sons, New York. First Edition, 1898. Size, 5 by 7 1-2. Pages, 290. With Many Illustrations. Cloth, $2.50.

This is a carefully prepared practical work for a specific purpose, viz.: "To provide in a convenient form such directions for the conduct of various tests and experiments, comprising the course, as the student will need to enable him to take charge of and conduct the particular work assigned to him in an intelligent manner and with little delay." Or in other words granted the reader has a theoretical knowledge of what he is about to undertake in the way of tests for efficiency, etc., this book will direct him how to proceed to put his theory into pactice, and if he is apt it will save him the trouble of asking a lot of questions. Each set of instructions is complete, so that the student will not have to hunt through the whole book for information necessary in any one test, but will rather find it properly labeled and ticketed where it belongs. Opening with a few practical suggestions on routine, the author treats successively of Measurements; time, speed, areas, lineal, liquids, gases, pressure, temperature and power. Then follow in order Strength of Materials; Steam Boiler Testing; Steam Engine Indicator; Testing of Hydraulic Machinery, and miscellaneous tests. Usual convenient tables of reference are attached, saving time in computation. Very appropriately, the author has selected for his frontispiece an engraving of the locomotive testing plant at Purdue, for this university is widely known as the place of origin of many important locomotive tests. In the text, too, he has given space to this special branch of laboratory work. Throughout the book there are a number of explanatory diagrams and drawings, and also some engravings showing the general appearance of apparatus referred to. These latter are mostly shopworn, and disfigure an otherwise neat and clearly printed book.

TRADE PUBLICATIONS.

Several types of valves manufactured by the Roe Stephens Mfg. Co., Detroit, Mich., are illustrated and briefly described in an 8-page folder, which is ready for distribution. Users of valves will find it instructive.

"There Is Nothing So Rare as Resting on Air" is the title to a pocket size pamphlet issued by the Pneumatic Mattress & Cushion Co., Reading, Mass. The explanation of the title can best be understood by sending for a copy of the pamphlet.

"How the Greatest Peril to Navigation Was Overcome" is the title of a 32-page pamphlet issued by the Eophone Co., 11 Broadway, New York. It tells in much detail what the eophone is and its many advantages for detecting sounds at sea and preventing collision. Copies can be had upon application to the company.

Powell's steam brass goods are described in a pocket edition catalogue of about 100 pages. The catalogue is thoroughly illustrated, averaging several pictures to a page, and is carefully indexed. In addition to the full line of goods manufactured by this company there is in it an amount of valuable information, mathematical, engineering, etc. Copies can be had by writing for them and mentioning MARINE ENGINEERING, to Wm. Powell Co., Cincinnati, O.

"Search Light Projectors" is the title of an exceptionally well printed and illustrated catalogue of 24 pages issued by the Carlisle & Finch Co., 834 West Sixth street, Cincinnati, O. The illustrations are excellent, and the printing in red and black gives a neat effect. Altogether it is a very satisfactory catalogue, and one that every user of search lights will find quite valuable for purposes of reference and general information. Copies can be had upon application to the company.

Steam regulating devices and steam pumps manufactured by the Mason Regulator Co., 6 Oliver street, Boston, Mass., are thoroughly illustrated and described in much detail in a 40-page pocket-size price list and catalogues just issued. Many of these devices are particularly designed for marine work, making the catalogue quite a necessary feature among the reference publications of every use of such devices. Copies of the catalogue can be had upon application to the company.

The American School of Correspondence, 156 Tremont street, Boston, Mass., has issued a small folder of testimonials of students who have taken a course at this institution. The school is chartered by the State of Massachusetts for the special purpose of giving a technical and practical education, by means of correspondence, to young men who have not the time nor the means to attend any of the established schools. The list of instructors include some eminent mechanical experts. Copies of this catalogue and other information can be had upon application.

BUSINESS NOTES.

VERMIN EXTERMINATORS.—One of the worst pests on board vessels of all kinds is the roach, which is difficult to exterminate. A remedy made especially for destroying roaches and ants is offered by the Allison Chemical Co., 143 East 23d St., New York.

ELECTRIC LIGHT ENGINES.—Marine electric plants need an engine of peculiar capabilities, and in order to supply the demand, the Fore River Engine Co., Weymouth, Mass., carries in stock a number of sizes of engines made especially for direct connected electric work.

MATTRESSES AND CUSHIONS.—The Perfection matresses and cushions, manufactured by the Mechanical Fabric Co., Providence, R. I., are made with special reference to marine work. It is claimed for them that they are always dry, that there is no mustiness.

SAIL MAKING.—M. W. Fogg, 195 Front St., New York, reports a larger volume of business than he has ever experienced at this season of the year. His shop is full of work for sails, covers, cushions and other work in his line, both for merchant vessels and for yachts. His facilities are not taxed to such an extent however as to preclude filling orders promptly.

A COLD PROCESS OF GALVANIZING.—A new process for galvanizing is being put on the market by the U. S. Electro-Galvanizing Co., 346 Broadway, New York. Many advantages are claimed for this process, among them the following: Screws and nuts need no recutting, tools, locks and almost anything metallic can be plated, springs preserve their elasticity and temper, as no heat is used, designs retain their original form, as their coating is uniform, sheet metal or wire can be bent without injury to the galvanizing, the operation is thorough, so that salt water does not cause oxidation, much less metal is wasted.

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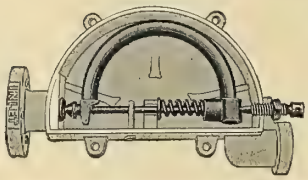

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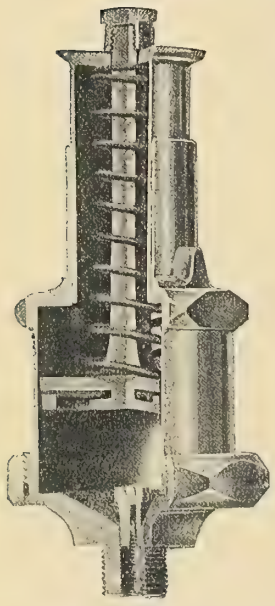

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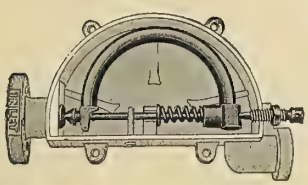

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ICE YACHTS.—A department for building ice yachts has been established by the Spalding St. Lawrence Boat Co., Ogdensburg, N. Y. This department is under the charge of Mr. George E. Buckhout, one of the leading designers and builders of ice yachts.

CONCERNING MECHANICAL DRAFT.—The elaborate treatise on mechanical draft recently issued by the B. F. Sturtevant Co., of Boston, Mass., is unique as a trade publication, in that it presents no personal claims for the merit of the system or the apparatus necessary for its operation, but relies solely on the statements of unbiased witnesses to emphasize its features. For this reason, the following quotation from this important work is of especial interest and value. It consists of a summary of the especial advantages of mechanical draft as presented by the well-known engineer, Mr. Alfred Blechyden, in a paper before the British Institution of Mechanical Engineers. He says: "First, it seems fairly well established that, if the boilers are well constructed and are provided with ample room to insure circulation, their steaming power may without injury, be increased to about 30 to 40 per cent over that obtained on natural draft for continuous working, and may be about doubled for short runs. Secondly, such augmentation is accompanied, in normal cases, by an increased consumption per indicated horse power. But, thirdly, the same or even greater power being indicated it may, with moderate assistance of forced draft, be developed with a smaller expenditure of fuel, the grates, etc., being properly proportioned. Fourthly, forced draft enables an inferior fuel to be used; and, fifthly, under certain conditions of weather, when with normal proportions of boiler it would be impossible to maintain steam with natural draft, the normal power may with forced draft be ensured. In particular cases any or all of these advantages may be a source of economy; and the first of them may render possible that which would otherwise be impracticable."

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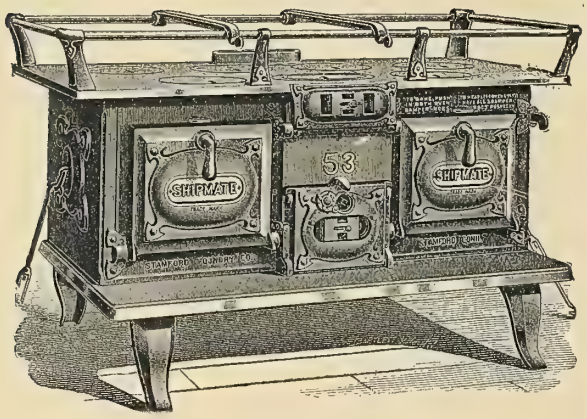
BETHLEHEM FORGINGS.—The steam yacht Oriénta, which is owned by Mr. Edward R. Ladew, of New York, broke her main shaft on the morning of the Naval Review in New York Harbor. An order for a new shaft has been placed with the Bethlehem Iron Co., South Bethlehem, Pa.

MARINE FIRE ALARM TELEGRAPH.—A committee of fire underwriters recently made an exhaustive test of the multiphase cable manufactured by the Montauk Fire Alarm Co., 100 Broadway, New York. In closing the report the committee said: "It is simple in action, and reliable as a fire alarm adjunct. The Montauk Multiphase Cable is practically a substitute for a thermostat, and this cable being run in out-of-the-way places, or in dangerous localities where fire is liable to occur, really makes a continuous thermostat, ready at all times for action in case of fire or dangerous heat at any point where the cable runs." This cable is particularly adapted to wiring vessels.



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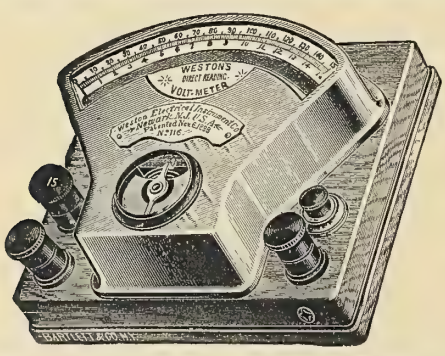

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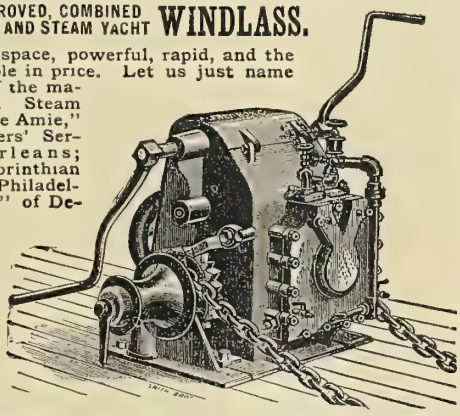

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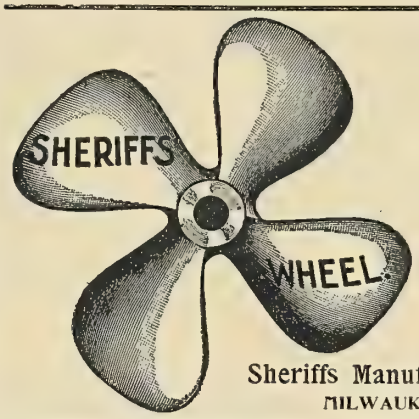

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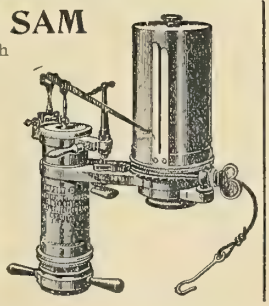

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Jas. L. Robertson & Son, 218 FULTON ST. Boston Branch, 12 PEARL ST.

USE OF THE NAME PENBERTHY.—Judge Adams, of the Federal Court, has handed down a decision in favor of the Penberthy Injector Co., Detroit, Mich., against the organizers of the Lee-Penberthy Co., enjoining the use of the name Penberthy by that company and charging costs to the defendant.

MR. CLARK MERCHANT.—Mr. Clark Merchant, of Philadelphia, and Lieutenants Etting and Thackera in 1894 were the means of first starting the Naval Reserves of the State of Pennsylvania. Mr. Merchant was born at Oglethorpe Barracks, Savannah, Ga., in 1836. His grandfather, George Merchant, fought in the War of 1812, and his father, Charles Spencer Merchant, was one of the first cadets admitted to West Point. Clarke Merchant was entered in the United States Naval Academy as a cadet, and graduated as a midshipman in 1857. He was executive officer of the steamer "Toey-wau" and present when the English squadron was defeated by the Chinese forts on the Peiho river, his vessel towing the boats containing the English sailors and marines into action. Commodore Tatnall on this occasion made the memorable declaration that "blood is thicker than water." He served through the Civil War, and at the close of the war was ordered to the Naval Academy at Newport as executive officer of the frigate "Constitution." He resigned from the navy in 1865. His present business started by his becoming agent for the New Bedford Copper Co., handling principally sheathing metal. To this he soon added sheet copper, tin and other metals. More space became necessary, and Mr. Merchant moved to 525 Arch street and subsequently to 517 Arch street, where he now ocupies a store especially erected for the business. In this are stored the brass, tin, iron and other metals which make up the stock of the firm. He deals very extensively in brass and copper tubing, coppersmith's supplies, anti-friction metal, and almost all materials for shipwork. There are branch offices in New York, Chicago and London.

Westinghouse Machine Co.

....MANUFACTURERS....

Westinghouse, Church, Kerr & Co., Engineers

We Employ the Best Materials and the Highest Skill in the Manufacture of Our Ice Refrigerating Plants

Builders of the Engine Holding the World's Record for Economic Duty

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PITTSBURG, Westinghouse Building DETROIT, Union Trust Building
PHILADELPHIA, M. R. MUCKLE, Jr., & CO., Drexel Building

PNEUMATIC TOOL PATENTS.—Judge Alfred C. Coxe, of the United States Court, has just rendered a decision in the case of the American Pneumatic Tool Co. vs. Volkening & Co., in which he sustains the validity of the Bagnasco patent, No. 474,154, for a valveless tool, owned by the American Pneumatic Tool Co., 844 Washington street, New York, and he finds that the defendants are infringers of this patent in the use of the infringing tool commonly known as the Keller tool.

A FREE SMOKE.—Every engineer who sends his address to the Litofuge Mfg. Co., 1710 Market St., Philadelphia, Pa., will receive a fine briarwood English bulldog pipe. These pipes are given for the special purpose of pushing the sale of Litofuge for keeping boilers clean. It is claimed to free the dirtiest boiler from scale in a short time, and to prevent the formation of scale in new or clean boilers. Pamphlets and other literature regarding Litofuge are sent to all inquirers.

APPARATUS FOR REVENUE CUTTER.—Revenue cutter No. 6, described in the October issue of Marine Engineering, and which is to be stationed in New York Harbor when completed, is fitted with Craig Heating and Circulating Apparatus, furnished by William Craig, 121 Liberty St., New York.

HOWDEN HOT DRAFT.—In a recent letter to the Dry Dock Engine Works, Detroit, Mich., Mr. Howden, the inventor of the hot draft system, reported having more orders on hand than at any time in the history of his business, the total installations throughout the world to date being 814 steamers with 2,277,300 I. H. P. Recent orders have been from steamers of unusually large power and among the customers are the following lines: Cunard line, Pacific Co., Orient Co., P. & O. Co., Atlantic Transport Line, Anglo-American Oil Co., Allan Line, Austrian Lloyds, Hamburg-American line, North German Lloyds, Russian Volunteer Fleet, French Line, Rotterdam Lloyd, Nederland Co., etc., etc.

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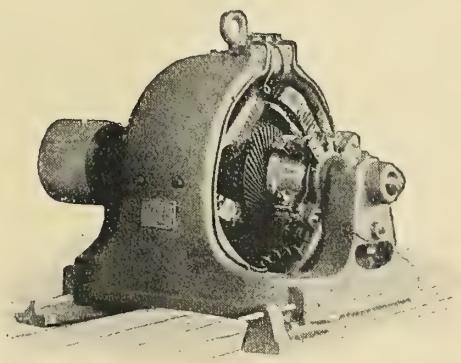

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Westinghouse Direct Current Multipolar Motor

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New York, Atlanta, Austin, Boston, Buffalo, Chicago, Cincinnati, Philadelphia, St. Louis, San Francisco, Syracuse, Tacoma, Denver, Mountain Electric Co. Canada, Ahearn & Soper, Ottawa. Mexico, G. & O. Braniff & Co., City of Mexico. Westinghouse Electric Co., Ltd., 32 Victoria St., London.

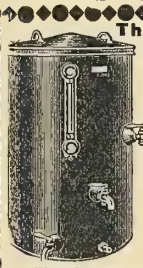
METALLIC PACKING.—Engineer Joseph F. Hayes, of the Zenith Transit Co., Duluth, Minn., wrote under recent date to the U. S. Metallic Packing Co., Philadelphia, Pa., as follows: "I have your packing on the Zenith City and Queen City, carry 225 lbs. of steam; on the Crescent, Empire, and Superior City carry 250 lbs. of steam. The Superior City has the record for ore and grain for a steamer up to date. Will say that the packing is working first rate on all the boats this season, and don't know what we would do without it with that pressure."

SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

BUILDER AND ARCHITECT SEEKS POSITION.

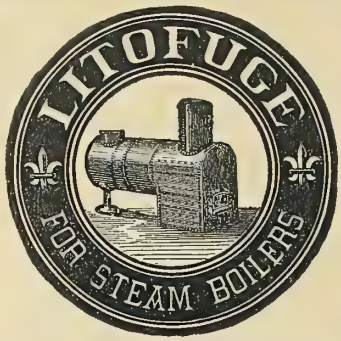
I wish to engage with a firm of Yacht or Launch Builders as Superintendent, Naval Architect, or in a position where ability and experience will count. Have had long and successful experience with well-known firms as Foreman, Superintendent and Naval Architect; have thorough knowledge of details, costs and construction. Can turn out work at reasonable cost and without waste. Am experienced with Steam and Gasoline Engines, have designed a number of successful Yachts and Launches and can introduce a large amount of paying business to a good firm. Address ARCHITECT,
MARINE ENGINEERING.



The **CROSS OIL FILTER**

actually reduces oil bills 50% or more. Sent on approval. Used in 17 countries. Adapted to steam vessels of every description. Send for circulars, testimonials, etc.

THE BURT MANUFACTURING CO.
AKRON, OHIO, U. S. A.
The Largest Manufacturers of Oil Filters in the World.



Free to Engineers.

Upon receipt of name and address and where employed, a fine English bulldog

BRIAR WOOD PIPE.

There's nothing like LITOFUGE for Marine Boilers.

It won't cost you a cent to try **LITOFUGE** unless it does just what we say it will do. We claim—

That it will clean the dirtiest boiler in 60 to 90 days, without injuring the metals;

That it is the *only* Compound that will *positively* prevent the formation of scale in a new or clean boiler;

That it will prevent corrosion, and stop it where it has already started;

That it does not eat the scale; simply loosens it from the metals.

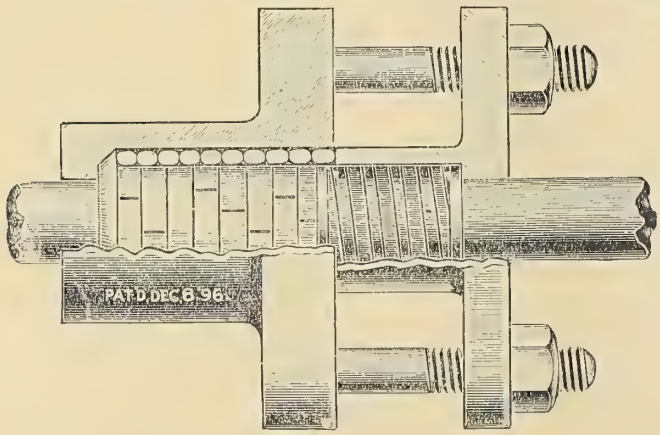
LITOFUGE acts mechanically (not chemically), contains no soda, soda ash, nor acid. Give us nominal horse power of your boilers and character of water used, and we will send you, freight prepaid, a trial order, to be paid for ***only*** if satisfactory. Pamphlet for the asking.

LITOFUGE MFG. CO.,
1710-1712 Market Street, PHILADELPHIA, PA.

There are a Number

of mediocre metallic packings on the market—some of them work fairly well for a short time—some of them work poorly from the start—all of them give more or less trouble—they cannot be adjusted while under load—they are dependent upon the steam or other pressure for their grip—they—but what's the use of talking? Like everyone else **YOU** are looking for a metallic packing combining the most good points with the fewest weak points; **WE** have found it and want **YOU** to know that—

RIGBY PATENT METALLIC ROD PACKING IS WITHOUT A PEER.



IT WILL HOLD—
Steam, Gas, Air, Water, Ammonia.

IT WILL WORK
at either light or heavy pressure with minimum friction.

IT WILL NOT
Grip nor Cut. Wear Out.

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